

Automatic rail-weighbridges

Part 1: Metrological and technical requirements – Tests

| International Organisation of Legal Metrology (OIML)

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EXPLANATORY NOTE

This draft revision of OIML R 106-1 developed by the OIML TC 9/ SC 2 *Automatic weighing instruments*, following consultations in 2004 for the need to update the technical and metrological specifications in the Recommendation in line with developments in the instrument and in legal metrology. This first committee draft was prepared in response to the comments received on the working draft revision in January 2005.

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FOREWORD

The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States.

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TERMINOLOGY (Terms and definitions)

The terminology used in this Recommendation conforms to the *International Vocabulary of Basic and General Terms in Metrology* (VIM) [1], the *International Vocabulary of Legal Metrology* (VIML) [2], the *OIML Certificate System for Measuring Instruments* [3], and to the *OIML International Document for General requirements for Electronic Measuring Instruments* [4]. In addition, for the purposes of this Recommendation, the following definitions apply.

T.1 General definitions

T.1.1 Mass

The property of a railway vehicle that causes it to have weight in a gravitational field.

T.1.2 Load

Deleted: A physical quantity the base unit of which is the kilogram.

The quantity representing a fraction of the railway vehicle mass due only to the vertically-downward force of gravity as applied on the instrument via a wagon, wheel, single axle or bogie.

T.1.3 Weight

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Material measure of mass that is regulated in regard to its physical and metrological characteristics and maximum permissible error (OIML R 111) [5].

T.1.4 Weighing

Process by which the mass of a train, wagon, single axle or bogie of a wagon is determined.

T.1.5 Weighing instrument

Measuring instrument used to determine the mass of a wagon or train by using the action of gravity on the railway vehicle.

The instrument may also be used to determine other quantities, magnitudes, parameters or characteristics related to the determined mass, e.g. wheel load, single axle load or bogie load of a wagon.

According to its method of operation, a weighing instrument is classified as automatic or non-automatic.

T.1.6 Automatic weighing instrument

An instrument that weighs that follows a predetermined program of automatic processes characteristic of the instrument.

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T.1.7 Automatic rail-weighbridge

An automatic weighing instrument having load receptor(s), inclusive of rails for conveying railway vehicles and recognises railway vehicles as vehicles to be weighed.

T.1.8 Railway vehicle

A wheeled vehicle (train or wagon) adapted to the rails of an automatic rail-weighbridge that is recognised by the instrument as a vehicle to be weighed.

T.1.9 Wagon

A loaded or unloaded wagon that is recognised by the automatic rail-weighbridge as a railway vehicle to be weighed.

T.1.10 Reference wagon

A wagon of known mass that is typical of those normally weighed on the automatic rail-weighbridge and which has been selected for the purposes of in-motion weighing.

T.1.11 Uncoupled wagon

A single reference wagon not joined together with another wagon whose individual mass is to be obtained.

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T.1.12 Coupled wagon

A number of reference wagons that are joined together with couplings whose individual or collective mass are to be determined.

T.1.13 Train

A number of wagons (excluding the locomotive) whose totalized mass are to be obtained.

T.1.14 Electronic instrument

An instrument equipped with electronic devices.

T.1.15 Control instrument

A weighing instrument used to determine the static reference wagon mass or the static single-axle loads of a reference wagon.

Control instruments used as a reference instrument during testing may be:

- separate from the instrument being tested, or
- integral, when a static weighing mode is provided by the instrument being tested.

T.1.16 Conventional true value (of a quantity)

A value attributed to a particular quantity and accepted, sometimes by convention, as having an uncertainty appropriate for a given purpose. [Adapted from VIM 1.20]

T.1.17 Metrological authority

An authorised representative of a national service of legal metrology such as an approving or testing authority, or a manufacturer himself provided that – according to national rules his quality system is acknowledged for ascertaining and confirming that the instrument satisfies all or parts of the requirements of this Recommendation.

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Deleted: T.1.12 Accuracy of a measuring instrument¶
¶ The ability of a measuring instrument to give responses close to a true value [based on VIM 5.18]. Note: Accuracy is a qualitative concept.

T.2 CONSTRUCTION

Note: In this Recommendation the term «device» is used for any means by which a specific function is performed irrespective of the physical realization e.g. by a mechanism, a key or a or a special function of the software initiating an operation; the device may be a small part or a major portion of an instrument.

T.2.1 Controlled weighing area

A place specified for the operation of instruments for weighing railway vehicles in motion which is in conformity with the requirements in this Recommendation.

T.2.2 Weigh zone

Zone comprising the load receptor(s) with aprons in advance and beyond either end of the load receptor in the direction of travel of the railway vehicle.

T.2.2.1 Apron

A part of the weigh zone that is not the load receptor but which is located on either end of the load receptor and serves as approach tracks in the direction of travel of the railway vehicle.

T.2.3 Load receptor

The part of the instrument intended to receive the load and which realises a change in the balance of the instrument when a load is placed upon it, and indicates or records the results.

T.2.3.1 Single load receptor

A load receptor that can support:

- a single wheel of an axle;
- all the wheels of a single uncoupled wagon simultaneously for full-draught weighing; or
- all the wheels of an axle or of a bogie simultaneously for axle or bogie partial static weighing of a single uncoupled wagon.

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Two or more load receptors may be placed in series to be used as a single load receptor for full-draught static weighing.

T.2.3.2 Load-transmitting device

Part of the instrument for transmitting the force produced by the load acting on the load receptor to the load-measuring device.

T.2.3.3 Load-measuring device

Part of the instrument for measuring the load, and a recording device which records and indicates the measurement result in units of mass.

Deleted: an indicating

T.2.4 Electronic instrument

An instrument equipped with electronic devices.

T.2.4.1 Electronic device

A device comprised of electronic sub-assemblies and performing one or more specific functions. An electronic device is usually manufactured as a separate unit and may be capable of being independently tested.

Deleted: T.2.3.5 Load conveyor Device to move the loads on to and off the load receptor. T.2.3.6 Load transport system The system used to transport the load over the load receptor.¶

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T.2.4.2 Electronic component

The smallest physical entity that uses electron or hole conduction in semiconductors, gases, or in a vacuum.

T.2.5 Module

Identifiable part of an instrument or device that performs a specific function or functions, and that can be separately evaluated according to the metrological and technical performance requirements in the relevant Recommendation. The modules of a weighing instrument are subject to specified partial error limits.

Note: Typical modules of an automatic weighing instrument are: load sensor, indicator, analogue or digital data processors, weighing module.

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T.2.5.1 Load sensor

A module that detects the value or the change of value of a physical quantity or parameter and converts the value into a signal for an indicating or recording instrument.

The following types of load sensor can be distinguished: load cells and fibre optic sensors.

T.2.5.1.1 Load cell

Force transducer which, after taking into account the effects of the acceleration of gravity and air buoyancy at the location of its use, measures mass by converting the measured quantity (mass) into another measured quantity (output) [OIML R60 (2000) [6].

Load cells equipped with electronics containing amplifier and analogue-to-digital conversion (ADC), and data processing (optionally) are called digital load cells

T.2.5.1.2 Fibre optic sensor

A sensor based on some optical property that can be detected by light reflected back through an optical fibre. Changes in the measurand are converted into another measured quantity (output) through the intensity variation of light in a fibre.

T.2.5.1.3 Laser sensor

A sensor based on light amplification by the stimulated emission of radiation that creates a uniform and coherent light to deliver a collimated single wavelength. Changes in the measurand through deflection measurement are converted into another measured quantity (output).

T.2.5.2 Indicator

Electronic instrument that performs the analogue-to-digital conversion of the output signal of the load sensor, and further processes the data, and displays the measurement result in units of mass.

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T.2.5.3 Analogue data processing module

Electronic instrument that performs the analogue-to-digital conversion of the output signal of the load sensor, and further processes the data, and supplies the measurement result in a digital format via a digital interface without displaying it. It may optionally have one more keys to operate the instrument.

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T.2.5.4 Digital data processing module

Electronic instrument that further processes the data, and supplies the measurement result in a digital format via a digital interface without displaying it. It may optionally have one or more keys to operate the instrument.

T.2.5.5 Weighing module

That part of the weighing instrument that comprises all mechanical and electronic devices (i.e. load receptor, load sensor, and analogue data processing device) but not having the means to display the measurement result. It may optionally have devices for further processing (digital) data and operating the instrument.

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T.2.6 Software

T.2.6.1 Legally relevant software

Programs, data and type-specific parameters that belong to the measuring instrument or device, and define or fulfil functions which are subject to legal control.

Examples of legally relevant software are: final results of the measurement including the decimal sign and the unit, identification of the weighing range and the load receptor(s).

The following types of legally relevant software can be distinguished: type-specific parameter and device-specific parameter.

Deleted: T.2.5.6 TerminalDigital device that has one or more keys to operate the instrument, and a display to indicate the weighing results transmitted via the digital interface of a weighing module or an analogue data processing device.T.2.5.7 Remote displayTerminal without keys that can be used for the primary indications or for their repetition.¶

T.2.6.2 Type-specific parameter

Legally relevant parameter with a value that depends on the type of instrument only. They are fixed at type approval of the instrument.

Examples of type-specific parameters are: parameters used for mass calculation, stability analysis or price calculation and rounding, software identification

T.2.6.3 Device-specific parameter

Legally relevant parameter with a value that depends on the individual instrument. Such parameters comprise calibration parameters (e.g. span adjustments or corrections) and configuration parameters (e.g. maximum capacity, minimum capacity, units of measurement, etc). They are adjustable or selectable only in a special operational mode of the instrument may be classified as those that should be secured (unalterable) and those that may be accessed (settable parameters) by an authorised person.

T.2.6.4 Software identification

A sequence of readable characters of software, and that is inextricably linked to the software (e.g. version number, checksum).

T.2.7 Data storage device

Storage device used for recording and keeping data ready after completion of the measurement for later legally relevant purposes

Storage may be integrated with the instrument (e.g. non-removable data storage such as a hard disk, or removable storage, e.g. diskettes, rewritable compact disks). Storage may also be on a universal computer system (multitasking operating system where storage can be moved within the universal system), or a remote system, e.g. file server located anywhere, e.g. in the same building or even in a different country. Thus the communications link to storage devices may be direct, or indirect, whereby there might be an intermediate storage phase not under the control of the user, e.g. dial-up on Internet.

T.2.8 Communication interface

An electronic, optical, radio or other hardware and software interface that enables information to be automatically passed between instruments and modules.

T.2.9 User interface

An interface that enables information to be passed between a human user and the instrument or its hardware or software components, as, e.g. switch, keyboard, mouse, display, monitor, printer, touchscreen.

T.2.10 Protective interface

Interface which allows the introduction of only such data into the data processing device of the instrument, which cannot

- display data, that are not clearly defined and could be taken for a measurement result,
- falsify displayed, processed or stored measurement results or primary indications,
- adjust the instrument or change any adjustment factor

T.2.9 Ancillary devices

T.2.9.1 Zero-setting device

Device for setting the indication to zero when the load receptor is empty.

T.2.9.1.1 Non-automatic zero-setting device

A zero-setting device that must be operated manually.

T.2.9.1.2 Semi-automatic zero-setting device

A zero-setting device that operates automatically following a manual command.

T.2.9.1.3 Automatic zero-setting device

A zero-setting device that operates automatically and without the intervention of an operator.

T.2.9.2 Zero-tracking device

A device for maintaining the zero indication within certain limits automatically.

T.2.9.3 Printing device

Part of a measuring instrument that produces hardcopies of the measurement results.

T.3 Metrological characteristics

T.3.1 Weighing

T.3.1.1 Full draught weighing

Weighing a wagon that is entirely supported on the single load receptor (see T.2.3.1).

T.3.1.2 Partial weighing

Weighing a single wagon in two or more parts (i.e. axle or bogie partial static weighing) successively on the single load receptor. The results are automatically added to indicate and record the wagon mass.

Deleted: The means to print the weight values of wagons weighed on the instrument and/or a summation of those wagon weights.¶

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T.3.1.3 Weighing-in-motion (WIM)

Weighing wagons that are in motion.

T.3.1.3.1 Uncoupled wagon weighing

Weighing-in-motion of wagons that travel independently across a single load receptor. (This is usually achieved by means of an incline of the approach to the load receptor).

T.3.1.3.2 Coupled wagon weighing

Weighing-in-motion of a train of coupled wagons to obtain the mass of the individual wagons.

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T.3.1.3.3 Train weighing

Weighing-in-motion of a number of wagons in a train (excluding the locomotive) to obtain a totalized mass of all the wagons.

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T.3.1.4 Static weighing

Weighing a single uncoupled wagon and test loads that are stationary to obtain a mass value.

T.3.1.5 Wagon mass (WM)

Mass of the single uncoupled wagon combination.

T.3.1.5.1 Maximum wagon mass

The largest wagon mass that the installation is approved to weigh-in-motion for a particular weighing site.

T.3.1.5.2 Minimum wagon mass

The wagon mass below which a weighing-in-motion result may be subject to an excessive relative error.

T.3.1.6 Train mass

Mass of the train combination including all wagons and excluding the locomotive.

T.3.1.7 Axle

An axle comprises two wheel assemblies with centres of rotation lying approximately on a common axis extending the full width of the wagon and oriented transversely to the nominal direction of travel of the wagon.

T.3.1.8 Bogie

A set of two or more axles included in a defined group at each end of a wagon and their respective interspaces.

Note: The criteria for defining various bogies may be set by national regulation.

T.3.1.9 Axle load

The fraction of the wagon mass that rests via the axle on the load receptor at the time of weighing.

T.3.1.10 Static reference single-axle load

A single-axle load of known conventional true value determined statically for a two-axle wagon.

T.3.1.11 Bogie load

The sum of all axle loads in a defined bogie; a fraction of the wagon mass imposed on the static bogie from the effect of gravity at the time of weighing.

Note: The criteria for defining various bogies may be set by national regulation.

T.3.2 Capacity

T.3.2.1 Maximum capacity (Max)

The largest mass that the automatic rail-weighbridge is approved to weigh-in-motion without totalising.

T.3.2.2 Minimum capacity (Min)

The mass value below which a weighing-in-motion result before totalizing may be subject to an excessive relative error.

T.3.2.3 Weighing range

The range between the minimum and maximum capacities.

T.3.4 Scale interval (d)

A value expressed in units of mass for weighing-in-motion that is the difference between:

- the values corresponding to two consecutive scale marks for analogue indication, or
- two consecutive indicated and recorded values for digital indication.

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T.3.4.1 Scale interval for stationary load

A value expressed in units of mass for weighing railway vehicles or test weights that are stationary that is the difference between two consecutive indicated and recorded values.

T.3.5 Speed

Deleted: The scale interval used for static tests

T.3.5.1 Maximum operating speed (V_{max})

The greatest velocity of a wagon that the instrument is designed to weigh in-motion and above which the weighing results may be subject to an excessive relative error.

T.3.5.2 Minimum operating speed (V_{min})

The lowest velocity of a wagon that the instrument is designed to weigh_in-motion and below which the weighing results may be subject to an excessive relative error.

T.3.5.3 Range of operating speeds

The difference between the minimum and maximum operating speeds at which a wagon may be weighed-in-motion.

T.3.5.4 Maximum transit speed

The maximum speed, where appropriate, that a railway vehicle can travel on the weigh zone without producing a permanent shift in the performance characteristics of a weighing instrument beyond those specified.

T.3.6 Warm-up time

The time between the moment that power is applied to an instrument and the moment at which the instrument is capable of complying with the requirements.

T.3.7 Durability

Ability of an instrument to maintain its performance characteristics over a period of use.

T.3.8 Final weight value

Weighing value that is achieved when an automatic operation is ended and the instrument is completely at rest and balanced and there are no disturbances taking effect on the indication.

Note: This definition is only applicable to static weighing and not to weighing-in-motion.

T.3.9 Stable equilibrium

The condition of the instrument such that the recorded weighing values of each separate weighing test show no more than two adjacent values; with one of them being the final weight value.

Note: This condition is only valid for each separate weighing test and not for a group of tests.

T.3.10 Discrimination

Ability of an instrument to react to small variations of load. The discrimination level, for a given load, is the value of the smallest additional load that, when gently deposited on or removed from

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the load receptor, causes a detectable change in the indication.

Deleted: perceptible

T.4 INDICATIONS AND ERRORS

T.4.1 Indication of a measuring instrument

Value of a quantity provided by a measuring instrument [VIM 3.2].

Note: "Indication", "indicate" or "indicating" includes both displaying and/or printing.

T.4.1.1 Primary indications

Indications, signals and symbols that are subject to requirements of this Recommendation.

T.4.1.2 Secondary indications

Indications, signals and symbols that are not primary indications.

T.4.2 Methods of indication

T.4.2.1 Digital indication

The measurement results are displayed by a digital measuring instrument in a digitized form [Adapted from VIM 4.11].

Deleted: An indication in which the scale marks are a sequence of aligned figures that do not permit interpolation to a fraction of the scale interval.¶

T.4.2.2 Analogue indication

The measurement results are displayed by an analogue measuring instrument in a form which is a continuous function of the measurand [Adapted from VIM 4.10].

T.4.3 Reading

T.4.3.1 Reading by simple juxtaposition

Reading of the weighing result by simple juxtaposition of consecutive figures giving the result, without the need of calculation.

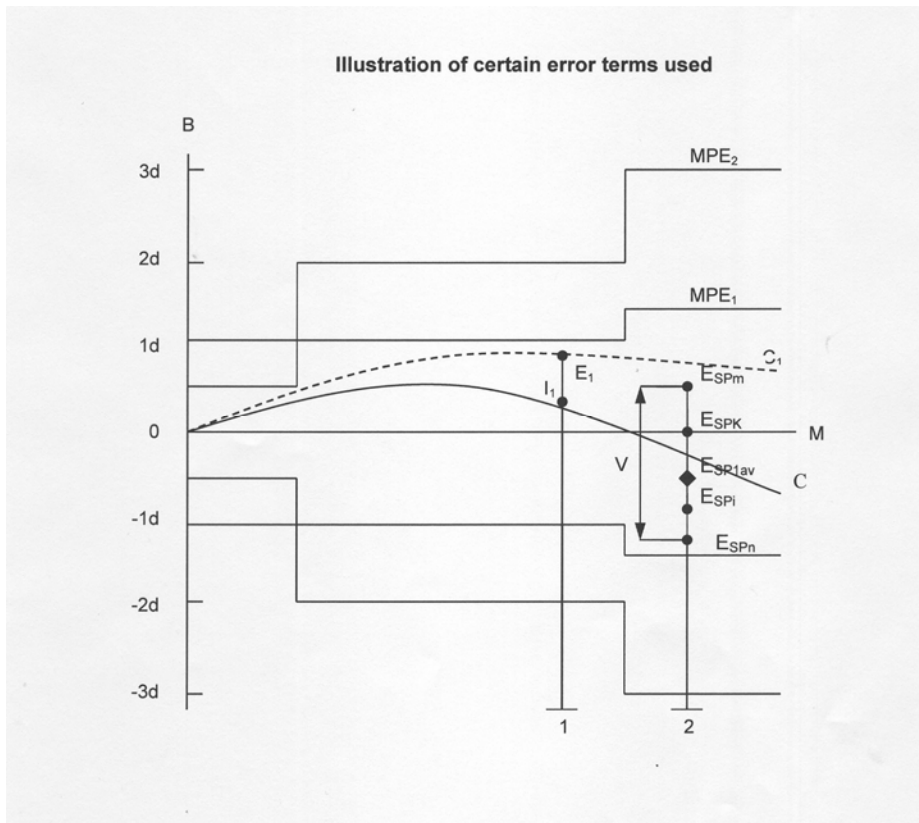
T.4.3.2 Overall inaccuracy of reading

The overall inaccuracy of reading of an instrument with analogue indication is equal to the standard deviation of the same indication, the reading of which is carried out under normal conditions of use by several observers.

T.4.4 Errors

See Figure 3 for illustration of certain terms used.

Figure 1



- M = mass to be measured
- E = error of indication (T.4.4.1)
- MPE₁ = maximum permissible error on initial verification
- MPE₂ = maximum permissible error in service
- C = characteristic under reference conditions
- C₁ = characteristic due to influence factor or disturbance (*)
- E_{SP} = error of indication evaluated during span stability test
- I = intrinsic error (T.4.4.2)
- V = variation in the errors of indication during span stability test

Situation 1 - shows the error E_1 of an instrument due to an influence factor or a disturbance. I_1 is the intrinsic error. The fault (see T.4.4.5) due to the influence factor or disturbance applied equals $E_1 - I_1$.

Situation 2 - shows the average value E_{SP1av} of the errors at the first measurement of the span stability test, some other errors E_{SPI} and E_{SPK} , and the extreme values of the errors, E_{SPm} and E_{SPn} , all these errors being evaluated at different moments during the span stability test. The

variation V in the errors of indication during the span stability test equals $E_{SPm} - E_{SPn}$.

(*) For the purposes of this illustration it is supposed that the influence factor or the disturbance has an influence on the characteristic which is not erratic.

T.4.4.1 Error (of indication)

The indication of an instrument minus the (conventional) true value of the corresponding input quantity. [VIM 5.20]

T.4.4.2 Intrinsic error

The error of an instrument determined under reference conditions. [VIM 5.24]

T.4.4.3 Initial intrinsic error

The intrinsic error of an instrument as determined prior to performance tests and durability evaluations.

T.4.4.4 Maximum permissible errors (MPE)

Extreme values of an error permitted by specifications or regulations between the indication of a weighing instrument and the corresponding true value, as determined by reference standard masses or weights, at zero or no load, in the reference position. [VIM 5.21]

T.4.4.5 Fault

The difference between the error of indication and the intrinsic error of a weighing instrument.

Principally, a fault is the result of an undesired change of data contained in or flowing through an electronic instrument. In this Recommendation, a "fault" is a numerical value.

Deleted: T.4.4.5 Maximum permissible deviation (MPD)¶
¶ Maximum permissible deviation of any wagon mass from the respective corrected mean of the same wagon weight.¶

T.4.4.6 Significant fault

A fault greater than 1 d.

The following are not considered to be significant faults:

- faults that result from simultaneous and mutually independent causes in the instrument or in its checking facility,
- faults that make it impossible to perform any measurement,
- transitory faults that are momentary variations in the indications which cannot be interpreted, memorised or transmitted as a measurement result,
- faults that are so serious that they will inevitably be noticed by those interested in the measurement.

T.4.4.7 Span stability

The capability of an instrument to maintain the difference between the indication of mass at maximum capacity and the indication at zero within specified limits over a period of use.

Deleted: weight

T.4.4.8 Rounding error

The difference between a digital measurement result (indicated and recorded) and the value of that measurement result with an analogue indication.

Deleted: T.4.4.9 Maximum span stability error¶

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A span stability error greater than one-half of the absolute value of the maximum permissible error applicable to the load.

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T.4.4.9 Repeatability error

The difference between the highest and lowest results of successive measurements of the same load carried out under the same conditions of measurement. [VIM 3.6]

Note: Repeatability conditions include:

- the same measurement procedure
- the same operator
- the same measuring instrument, used under the same conditions
- the same location
- repetition over a short period of time

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T.4.4.10 Durability error

The difference between the intrinsic error over a period of use and the initial intrinsic error of an instrument.

T.4.4.11 Significant durability error

A durability error greater than d.

Note: A durability error can be due to mechanical wear and tear or due to drift and ageing of electronic parts. The concept of significant durability error applies only to electronic parts.

T.5 INFLUENCES AND REFERENCE CONDITIONS

T.5.1 Influence quantity

A quantity that is not the measurand but that affects the result of the measurement.

T.5.1.1 Influence factor

An influence quantity having a value within the specified rated operating conditions of the instrument.

T.5.1.2 Disturbance

An influence quantity having a value that falls within the limits specified in this International Recommendation but that falls outside the rated operating conditions of the instrument.

T.5.2 Rated operating conditions

Conditions of use which give the ranges of the influence quantities for which the metrological characteristics are intended to lie within the specified maximum permissible errors.

T.5.3 Reference conditions

Conditions of use prescribed for testing the performance of a measuring instrument or for inter-comparison of results of measurements.

Note: The reference conditions generally include reference values or reference ranges for influence quantities affecting the measuring instrument. [VIM 5.7]

T.6 TESTS

T.6.1 Static test

A test with standard weights that remains stationary (test loads) on the load receptor to determine an error.

T.6.2 In-motion (dynamic) test

A test with reference wagons that are in motion on the load receptor to determine an error.

T.6.3 Simulation test

A test carried out on a complete instrument or part of an instrument in which any part of the weighing operation is simulated.

T.6.4 Performance test

A test to verify that the equipment under test (EUT) is capable of accomplishing its intended functions.

T.6.5 Span stability test

A test to verify that the EUT is capable of maintaining its performance characteristics over a period of use.

T.7 ABBREVIATIONS AND SYMBOLS

<u>Symbols</u>	<u>Meaning</u>
<u>I</u>	<u>Indication</u>
<u>I_n</u>	<u>nth indication</u>
<u>L</u>	<u>Load</u>
<u>ΔL</u>	<u>Additional load to next changeover point</u>
<u>P</u>	<u>I + 1/2 e – ΔL = Indication prior to rounding (digital indication)</u>
<u>E</u>	<u>I – L or P – L = Error</u>
<u>E%</u>	<u>(P - L)/L %</u>
<u>E₀</u>	<u>Error at zero load</u>
<u>d</u>	<u>Actual scale interval</u>
<u>p_i</u>	<u>Fraction of the MPE applicable to a module of the instrument which is examined separately.</u>
<u>MPE</u>	<u>Maximum permissible error</u>
<u>EUT</u>	<u>Equipment under test</u>
<u>sf</u>	<u>Significant fault</u>
<u>Max</u>	<u>Maximum capacity of the weighing instrument</u>
<u>Min</u>	<u>Minimum capacity of the weighing instrument</u>
<u>U_{nom}</u>	<u>Nominal voltage value marked on the instrument</u>
<u>U_{max}</u>	<u>Highest value of a voltage range marked on the instrument</u>
<u>U_{min}</u>	<u>Lowest value of a voltage range marked on the instrument</u>
<u>V_{min}</u>	<u>Minimum operating speed</u>
<u>V_{max}</u>	<u>Maximum operating speed</u>
<u>DC</u>	<u>direct current</u>
<u>AC</u>	<u>alternating current</u>

AUTOMATIC RAIL-WEIGHBRIDGES

1 General

1.1 Scope

This International Recommendation specifies the requirements and test methods for automatic rail-weighbridges, hereinafter referred to as “instruments”, which are used to determine the mass of railway wagons when they are weighed in motion.

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It is intended to provide standardized requirements and test procedures to evaluate the metrological and technical characteristics of such instruments in a uniform and traceable way.

1.2 Terminology

The terminology given in the terminology section shall be considered as a part of this Recommendation.

2 Metrological requirements

2.1 Accuracy classes

Instruments are divided into four accuracy classes as follows:

0.2 0.5 1 2

An instrument may be in a different accuracy class for wagon weighing than that for train weighing.

2.2 Maximum permissible errors (MPE)

2.2.1 Weighing-in-motion

The maximum permissible errors for weighing-in-motion shall be as specified in Table 1.

Table 1

Accuracy class	Percentage of mass of single wagon or train as appropriate	
	<u>Initial verification</u>	<u>In-service inspection</u>
0.2	±0.10 %	±0.20%
0.5	±0.25 %	±0.50%
1	±0.50 %	±1.00%
2	±1.00 %	±2.00 %

Note: On initial verification of an instrument weighing coupled wagons, the errors of not more than 10 % of the weighing results taken from one or more passes of the test train may exceed the appropriate maximum permissible error given in Table 1 and no result shall exceed two times that value. The upper graph of Figure 1, titled "Wagon Weighing," illustrates this requirement.

2.2.1.1 Wagon weighing

The maximum permissible error for uncoupled or coupled wagon weighing, shall not exceed one of the following values, whichever is greater:

- a) the value calculated according to the appropriate accuracy class in Table 1, rounded to the nearest scale interval;
- b) the value calculated according to the appropriate accuracy class in Table 1, rounded to the nearest scale interval for the mass of a single wagon equal to 35 % of the maximum wagon mass (as inscribed on the descriptive markings), or
- c) 1 d.

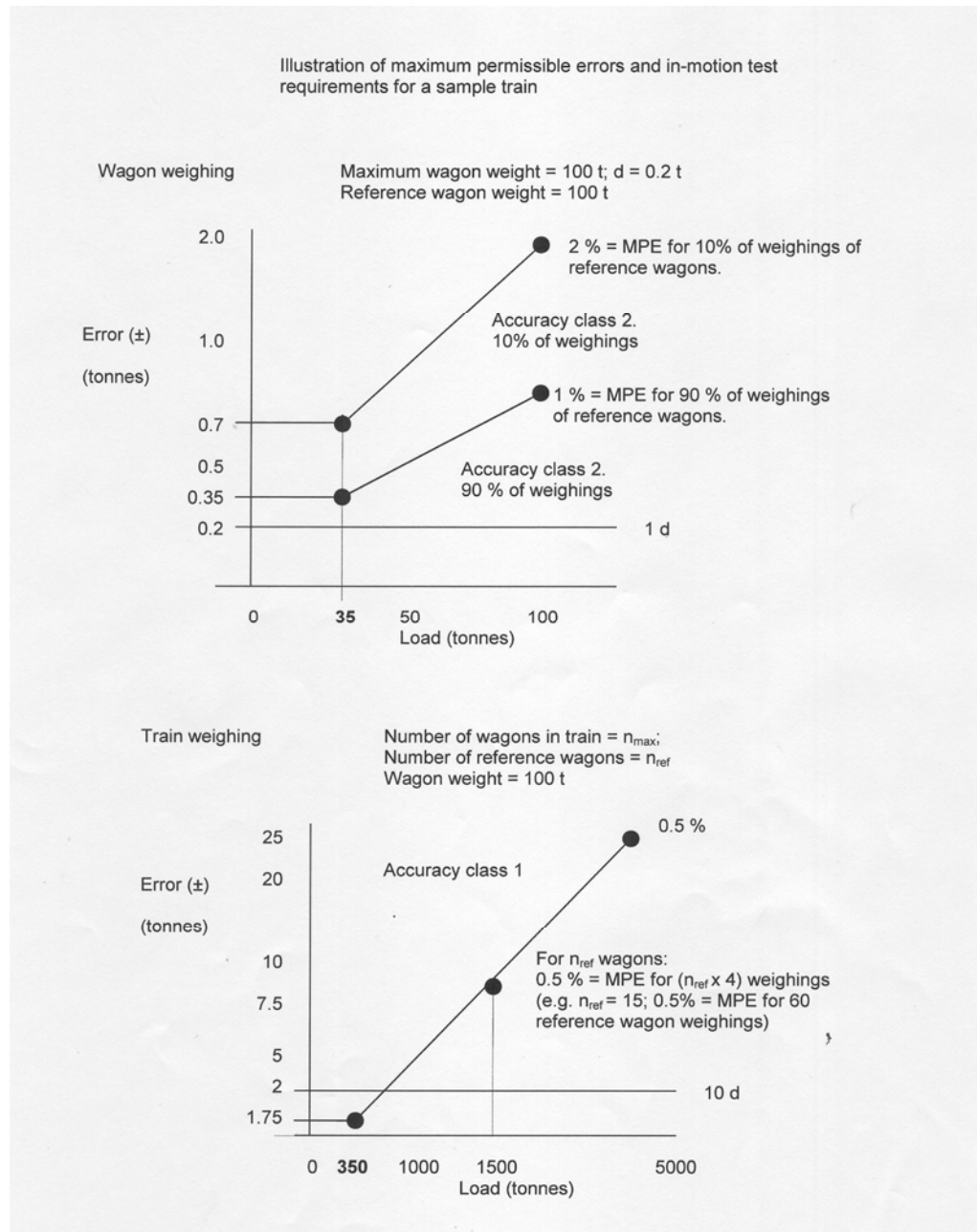
2.2.1.2 Train weighing

The maximum permissible error for train weighing shall be one of the following values, whichever is greater:

- a) the value calculated according to the appropriate accuracy class in Table 1, rounded to the nearest scale interval;
- b) the value calculated according to the appropriate accuracy class in Table 1, for the mass of a single wagon equal to 35 % of the maximum wagon mass (as inscribed on the descriptive markings) multiplied by the number of reference wagons in the train, and rounded to the nearest scale interval, or
- c) 1 d for each wagon in the train but not exceeding 10 d.

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Figure 2



2.2.2 Static weighing

The maximum permissible errors on static weighing for increasing or decreasing loads shall be the appropriate values in Table 3.

Table 2

Maximum permissible errors	Load (m) expressed in numbers of scale intervals
$\pm 0.5 d$	$0 \leq m \leq 500$
$\pm 1.0 d$	$500 \leq m \leq 2\,000$
$\pm 1.5 d$	$2\,000 \leq m \leq 10\,000$

2.3 Scale interval (d)

For a particular method of weighing-in-motion and combination of load receptors, all mass indicating, recording and printing devices on an instrument shall have the same scale interval.

The scale intervals of the indicating, recording and printing devices shall be in the form of 1×10^k , 2×10^k , or 5×10^k , "k" being a positive or negative whole number or zero.

The relationship between the accuracy class, the scale interval and the maximum wagon mass divided by the scale interval shall be as specified in Table 3.

Table 3

Accuracy class	d (kg)	(maximum wagon mass)/d	
		Minimum	Maximum
0.2	≤ 50	1000	5000
0.5	≤ 100	500	2500
1	≤ 200	250	1250
2	≤ 500	100	600

The rounding error included in any digital indication shall be eliminated if the actual scale interval is greater than 0.2 d.

2.4 Scale interval for stationary load

If the scale interval for stationary load is not equal to the scale interval (d), it shall be automatically out of service when the instrument is in use for weighing-in-motion. In addition, if the instrument is not verified for use as a non-automatic weighing instrument, the scale interval

for stationary load shall not be readily accessible and shall only be used for static testing during metrological controls.

2.5 Minimum capacity

The minimum capacity shall not be less than 1 t, and not greater than the value of the result of the minimum wagon mass divided by the number of partial weighings.

2.6 Minimum wagon mass

The minimum wagon mass shall not be less than 50 d.

2.7 Influence quantities

2.7.1 Temperature

2.7.1.1 Static temperature

Instruments shall comply with the appropriate metrological and technical requirements at temperatures from $-10\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$.

Depending on local environmental conditions and according to the application of the instrument, the instrument shall comply with the metrological requirements within those limits:

- the lower temperature limit shall be $-40\text{ }^{\circ}\text{C}$, $-25\text{ }^{\circ}\text{C}$, $-10\text{ }^{\circ}\text{C}$, or $+5\text{ }^{\circ}\text{C}$
- the higher temperature shall be $30\text{ }^{\circ}\text{C}$, $40\text{ }^{\circ}\text{C}$, $55\text{ }^{\circ}\text{C}$, $(70\text{ }^{\circ}\text{C})$, or $(85\text{ }^{\circ}\text{C})$

2.7.1.2 Temperature effect on no-load indication

The indication at zero or near zero shall not vary by more than one scale interval for a difference in ambient temperature of $5\text{ }^{\circ}\text{C}$.

Instruments shall be tested in accordance with the static temperatures test in A.7.2.2.

2.7.2 Power supply

An electronic instrument shall comply with the appropriate metrological and technical requirements, if the voltage supply varies from the nominal voltage, U_{nom} (if only one voltage is marked on the instrument), or from the upper and lower limits of the voltage range (U_{min} , U_{max}) marked on the instrument at:

- AC mains power: lower limit is $0.85 \times U_{nom}$ or $0.85 \times U_{min}$, upper limit is $1.10 \times U_{nom}$ or $1.10 \times U_{max}$;
- DC mains power: lower limit is the minimum operating voltage, upper limit is $1.20 \times U_{nom}$ or $1.10 \times U_{max}$;
- Rechargeable auxiliary battery power if (re)charge of batteries during the operation of the instrument is possible: lower limit is the minimum operating voltage, upper limit is $1.10 \times U_{nom}$ or $1.10 \times U_{max}$;

Note: The minimum operating voltage is defined as the lowest possible operating voltage before the instrument is automatically switched off.

Rechargeable battery-operated and DC mains powered instruments shall either continue to function correctly or not indicate any mass or load values if the voltage is below the manufacturer's specified value, the latter being larger or equal to the minimum operating voltage.

2.8 Units of measurement

The units of mass to be used on an instrument are:

- gram (g)
- kilogram (kg)
- tonne (t).

2.9 Agreement between indicating, recording and printing devices

For the same load, the difference between the measurement results provided by any two devices having the same scale interval shall be as follows:

- zero for digital devices;
- not greater than the absolute value of the maximum permissible error for weighing-in-motion for analogue devices.

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2.10 Operating speed

Operating speed shall be determined by the instrument as the average velocity of the railway vehicle as it moves over the load receptor. This speed shall be recorded in km/h. Operating speed shall be indicated and recorded only after the entire railway vehicle has been weighed in motion.

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km/h

3 TECHNICAL REQUIREMENTS

3.1 Suitability for use

Instruments shall be designed to suit the vehicles, site and method of operation for which they are intended.

3.2 Security of operation

3.2.1 Fraudulent use

An instrument shall have no characteristics likely to facilitate its fraudulent use.

3.2.2 Accidental maladjustment

Instruments shall be constructed so that maladjustments likely to disturb their metrological performance cannot normally take place without their effects being easily detected.

3.2.3 Interlocks

Interlocks shall prevent or indicate the operation of the instrument outside the specified working conditions. Interlocks required for:

- minimum operating voltage (2.7.2)
- vehicle recognition (3.7)
- wheel position on the load receptor (3.8)
- range of operating speeds (3.4.5.3)

3.2.4 Uncoupled wagon weighing

Instruments intended for uncoupled wagon weighing shall recognize and indicate the following situations:

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- a) the passage of a coupled wagon;
- b) the passage of two or more uncoupled wagons that is sufficiently close to cause either a malfunction of the instrument or errors exceeding the appropriate maximum permissible errors.

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3.2.5 Automatic operation

Instruments shall be designed to ensure that the accuracy and operation of the instrument is within the requirements of this Recommendation for a specified period (in accordance with national regulation) of normal use. Any malfunction shall be automatically and clearly indicated (e.g. by a fault indication or by automatic switch off). The documentation submitted by the manufacturer (A.1.1) shall include a description of how this requirement is met.

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The level of confidence shall take account of uncertainties of measurement, significant faults, overload situation, high speed and failure of the instrument.

3.2.6 Use as a non-automatic weighing instrument

An instrument to be used as a non-automatic weighing instrument shall

- comply with the requirements of OIML R76-1 [7] for class III or class III non-automatic weighing instruments;
- be equipped with an enabling device for non-automatic operation that prevents both automatic operation and in-motion weighing.

3.3 Zero-setting device

An instrument shall be equipped with a zero-setting device for each load receptor. These devices may be:


- semi-automatic, or
- automatic

A semi-automatic zero-setting device shall not be operable during automatic operation.

3.3.1 Accuracy

A zero-setting device shall permit setting the indication to zero with a deviation of not more than ± 0.25 d.

The effect of any zero-setting device shall not alter the maximum weighing capacity of the instrument.

The range the of zero-setting and zero-tracking devices shall not be more than 4 %, and of the initial zero-setting device not more than 20 %, of the maximum capacity. This does not affect an instrument of class , except if it is used for commercial transactions.

3.3.2 Zero indicating device on an instrument with digital indication

An instrument with digital indication shall have a device that displays a special signal when the deviation from zero is not more than 0.25 d.

3.3.3 Automatic zero-setting device

An automatic zero-setting device may operate at the start of automatic operation, as part of every automatic weighing cycle, or after a programmable time interval. A description of the operation of the automatic zero-setting device (e.g. the maximum programmable time interval) shall be included in the test report.

The automatic zero-setting device shall operate sufficiently to ensure that zero is maintained within 0.5 d.

Where the automatic zero-setting device operates as part of every automatic weighing cycle, it shall not be possible to disable this device or to set this device to operate at time intervals.

Where the automatic zero-setting device operates after a programmable time interval, the manufacturer shall specify the maximum time interval.

The maximum programmable time interval for automatic zero-setting required above may start again after zero tracking has taken place.

The actual maximum programmable time interval for automatic zero-setting shall be specified considering the actual operating conditions of the instrument. The automatic zero-setting device shall either automatically set to zero after the allocated time or should stop the instrument so that a zero-setting operation can occur or be capable of generating information to draw attention to overdue zero setting.

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¶
An instrument whether or not equipped with an initial zero-setting device, may have a combined semi-automatic zero-setting and semi-automatic tare-balancing device operated by the same key.¶
¶
If an instrument has a zero-setting device and a tare-weighing device the control of the zero-setting device shall be separate from that of the tare-weighing device.¶
¶
A semi-automatic zero-setting device shall function only:¶
¶
<#>when the instrument is in stable equilibrium (3.5.1).¶
<#>if it cancels any previous tare operation.¶
¶

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3.3.4 Zero-tracking device

A zero-tracking device shall operate only when the indication is at zero and the corrections are not more than 0.5 d per second.

When zero is indicated after a tare operation, the zero-tracking device may operate within a range of 4 % of Max around the actual zero.

Notes:

- (1) Zero-tracking is functionally similar to automatic zero-setting. The differences are important in applying the requirements of 3.5. Refer to T.2.6.1 and T.2.6.2. Zero-tracking may operate continuously (when the conditions of 3.9 are fulfilled for static weighing) and must therefore be subject to a maximum rate of correction (0.5 d/second) to prevent interaction with the normal weighing process.
- (2) Automatic zero-setting is activated by an event, such as part of every automatic weighing cycle or after a programmed interval. The maximum rate of correction applicable to zero-tracking does not apply to zero-setting.

3.4 Indication, recording and printing

3.4.1 Quality of indication

Reading of the primary indications (see T.4.1.1) shall be reliable, easy and unambiguous under conditions of normal use:

- the overall inaccuracy of reading of an analogue indicating device shall not exceed 0.2 d,
- the figures, units and designations forming the primary indications shall be of a size, shape and clarity for reading to be easy.

The indication shall be the self-indicating type and the scales, numbering and printing shall permit the figures which form the results to be read by simple juxtaposition (see T.4.3.1).

3.4.2 Printing device

Printing shall be clear and permanent for the intended use. Printed figures shall be at least 2 mm high.

If printing takes place, the name or the symbol of the unit of measurement shall be either to the right of the value or above a column of values, or placed in accordance with national regulation.

3.4.3 Indication and recording for normal operation

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The minimum indication and recording resulting from each normal weighing in-motion operation shall be dependent upon the application of the instrument, and shall include the date and the time, the operating speed, the instrument identification, and in the case of wagon weighing each wagon mass and in the case of train weighing each wagon mass and the train mass.

For normal operation the scale interval of indications and recordings for the individual wagon mass or the train mass shall be the scale interval d in accordance with 2.3.

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The scale interval of indications and recordings of measured or calculated mass values, may be to a higher resolution than the scale interval d.

The results shall bear the name or symbol of the appropriate unit of mass in accordance with 2.8.

3.4.4 Digital indication

Where the scale interval is changed automatically the decimal sign shall maintain its position in the display.

A decimal fraction shall be separated from its integer by a decimal sign (comma or dot, according to national regulation), with the indication showing at least one figure to the left of the sign and all figures to the right.

The decimal sign shall be on one line with the bottom of the figures (example: 0.705 kg).

A digital zero indication shall include the display of a zero for all places that are displayed to the right of a decimal point and at least one place to the left. When no decimal values are displayed, a zero shall be displayed for each place of the displayed division, (i.e. at least one active decade plus any fixed zeros must be displayed).

Below are examples of the number of zeros required:

Capacity	Minimum Zero Indication (kg)
25 x 0.01	0.00
5000 x 1	00
100 000 x 20	0

3.4.5 Limits of indication or recording of measurement results

3.4.5.1 Weighing capacity

Instruments shall not indicate or record:

- the mass of the locomotive;
- mass values ~~above~~ Max + 9 d.

Max is the maximum capacity of the load receptor (see T.3.2.1).

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3.4.5.2 Single axle or bogie load

Indications or recorded values of single axle loads or bogie loads shall only be possible during partial weighing of static reference wagons (A.9.3.1.2).

3.4.5.3 Operating speed

Interlocks shall prevent or indicate the mass of any wagon that has travelled over the load receptor at a speed outside the range of operating speeds.

3.4.5.4 Roll back

The indicated or recorded values of wagon mass shall not be altered due to any part of any wagon travelling over the load receptor more than once, unless the wagon is been reweighed.

Deleted: . An appropriate indication shall be included on the printout for any wagon mass not printed and a subtotal may be printed exclusive of unweighed wagons provided that an indication clearly specifies that it is not the train mass.

3.5 Totalising device

An instrument may be provided with a totalising device which totalises the mass of the individual wagons to provide a totalised mass. Operation of this device may be:

- 1) automatic, in which case the instrument shall be provided with a vehicle recognition device, or
- 2) semi-automatic (operates automatically following a manual command).

3.6 Recorded data storage

The primary indications and device-specific parameters may be recorded for storage in a memory of the instrument (hard drive), or on a universal computer storage, or on external storage for subsequent indication, printing, data transfer, totalising, etc. In all cases, the stored data shall be adequately protected against intentional and unintentional changes during the transfer process and stored data shall contain all relevant information necessary to reconstruct an earlier measurement.

For securing recorded data storage, the following apply:

- a) Software transmission and downloading process shall be secured in accordance with the requirements in 3.13;
- b) External storage devices identification and security attributes shall be verified to ensure integrity and authenticity;
- c) Exchangeable storage media is sealed against removing in accordance with 3.14;
- d) Device-specific parameters are not stored on the standard storages of the universal computer but in separate hardware that can be sealed in accordance with 3.14;
- e) When storage capacity is exhausted, new data shall replace oldest data.

National regulation may specify other requirements for securing stored data which provide sufficient integrity.

3.7 Vehicle recognition device

An instrument shall be provided with a vehicle recognition device when the wagon mass is indicated or recorded automatically following a weighing operation. The device shall detect the presence of a wagon in the weigh zone and shall detect when the whole wagon has been weighed.

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3.8 Vehicle guide device

An instrument equipped with a vehicle guide device shall not indicate or record the wagon mass if any part of the wagon did not pass fully over the load receptor.

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Deleted: Alternatively, a lateral guide system may be used to ensure that all the wheels of the wagon pass fully over the load receptor.¶

If only one direction of travel is specified for an instrument, an error message shall be given or the instrument shall not indicate or record the wagon mass if it travels in the wrong direction.

3.9 Stable equilibrium for static weighing

For static weighing, equilibrium is deemed to be stable when in case of indications and recordings, the indicated and recorded weighing values show no more than two adjacent values; with one of them being the final weight value.

Stable equilibrium requirement does not apply to weighing-in-motion.

3.10 Integral control instrument

3.10.1 Full-draught weighing

If the instrument under test is to be used as an integral control instrument, for the purposes of determining the wagon mass by full-draught weighing, it shall meet the requirements of 3.10.1 to 3.10.4 inclusive, and 6.1.

3.10.1.1 Zero-setting

The instrument shall permit setting the indication to zero with a deviation of not more than ± 0.25 of the scale interval for a stationary load (2.4).

3.10.1.2 Eccentric loading (6.2.4)

The indications for different positions of the load shall comply with the maximum permissible errors in 2.2.1 for the given load.

3.10.1.3 Discrimination

An additional load that is equal to 1.4 times the scale interval for a stationary load, when gently placed on or withdrawn from each load receptor in turn when at equilibrium at any load shall change the initial indication.

3.10.1.4 Repeatability

The difference between the results of several weighings of the same load shall not be greater than the absolute value of the maximum permissible error of the instrument for that load.

3.10.2 Bogie partial weighing

If the instrument under test is to be used as an integral control instrument, for the purposes of determining the wagon mass by bogie partial weighing, it shall meet the requirements of 3.10.2.1 to 3.10.2.5 inclusive.

3.10.2.1 Scale interval for stationary load

The scale interval for stationary load (for test purposes) shall be equal or smaller than $1/10 d$ for the weighing in motion mode.

3.10.2.2 Zero-setting

The instrument shall permit setting the indication to zero with a deviation of not more than ± 0.25 of the scale interval for a stationary load (2.4).

3.10.2.3 Eccentric loading (6.2.4)

The indications for different positions of the load (see test procedure) shall not be greater than one-half of the absolute value of the maximum permissible error (2.2.1) of the instrument for that load.

3.10.2.4 Discrimination

An additional load that is equal to 1.4 times the scale interval for a stationary load, when gently placed on or withdrawn from each load receptor in turn when at equilibrium at any load shall change the initial indication.

3.10.2.5 Repeatability

The difference between the results of several weighings of the same load shall not be greater than one-half of the absolute value of the maximum permissible error (2.2.1) of the instrument for that load.

3.11 Control instrument (separate or integral) for partial weighing of two-axle wagons

An instrument constructed only for partial weighing of two-axle wagons may be used as the control instrument (separate or integral) for determining the conventional true value of the reference wagon mass by individual axle measurement when stationary provided that:

- the alignment correction or exemption test for partial weighing instruments in Annex B has been successfully applied.
- it ensures the determination of the conventional true value of the static two-axle reference wagon mass to an error of at most one-third of the maximum permissible error for weighing-in-motion specified in 2.2.1

3.12 Installation

3.12.1 General

Weigh-in-motion instruments shall be manufactured and installed so as to minimise any adverse effects of the installation environment. The space between the load receptor and ground shall allow all covered parts of the load receptor to be kept free from all debris or other matter that could affect the accuracy of the instrument. Details of installation (e.g. site levels, length of aprons), which may affect the weighing operation shall be recorded in the test report. In addition, the following effects on the weighing results should be taken into account:

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- Lateral forces due to interactions of the control instrument with the railway vehicle.
- Forces on part of the railway vehicle by different transient behaviour and friction within the axle suspensions.
- Forces on part of the ramps if there are different levels between the control instrument and ramp that could lead to varying distribution of the axle load.

Further installation information is provided in Annexe C.

3.12.2 Composition

Instruments may include the following:

- one or more load receptors;
- aprons;
- vehicle-type identification devices (e.g. track switches, load sensors, transponder, etc);
- indicating device and recording device;
- data processing module.

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3.12.3 Ease of static testing

The instrument shall be accessible to vehicles for moving test weights if it is to be used as the control instrument.

3.12.4 Drainage

If the weighing mechanism is contained in a pit, there shall be a provision (e.g. automatic bilge pump) for drainage to ensure that no portion of the instrument becomes submerged or partially submerged in water or any other liquid.

3.12.5 Heating

If the weighing mechanism is installed in environment where temperatures below the minimum specified temperature can be expected, there shall be provision for heating to ensure that the instrument operates correctly within the requirements in this Recommendation.

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3.13 Software

The legally relevant software used in an instrument must be present in such a form in the instrument that alteration of the software is not possible without breaking a seal, or any change in the software can be signalled automatically by means of an identification code. The securing requirements in 3.14 apply. National regulation may specify other requirements for securing software which provide sufficient integrity.

The software documentation provided by the manufacturer shall include:

- A description of the legally relevant software;
- A description of the accuracy of the measuring algorithms (e.g. programming modes);
- A description of the user interface, menus and dialogues;
- The unambiguous software identification;
- A description of the embedded software;

- f) An overview of the system hardware, e.g. topology block diagram, type of computer(s), source code for software functions, etc, if not described in the operating manual;
- g) Means of securing software;
- h) The operating manual.

The following means of securing legally relevant software apply:

- a) Access shall only be allowed to authorised people, e.g. by means of a code (key-word) or of a special device (hard key, etc); the code must be changeable;
- b) It shall be possible for at least the last intervention to be memorised and it must be possible to access and display this information; the record shall include at least the ten most recent access or changes, the date and a means of identifying the authorised person making the intervention (see (a) above); the traceability of the last intervention shall be assured for at least two years, if it is not over-written on the occasion of a further intervention; if it is possible to memorise more than one intervention, and if deletion of a previous intervention must occur to permit a new record, the oldest record shall be deleted.
- c) Downloading of legally relevant software shall be through appropriate protective interface (T.2.10) connected to the instrument;
- d) The software shall be assigned with appropriate software identification (T.2.6.4). This software identification shall be adapted in the case of every software change that may affect the functions and accuracy of the instrument.
- e) Functions that are performed or initiated via a software interface shall meet the relevant requirements and conditions for interfaces of 4.3.5.

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3.14 Securing of components, interfaces and pre-set controls

3.14.1 General

Components, interfaces, software devices and pre-set controls subject to legal requirements that are not intended to be adjusted or removed by the user shall be fitted with a securing means or shall be enclosed. When enclosed, it shall be possible to seal the enclosure. However, other national prescribed types of securing are permitted which provide sufficient integrity.

Any device for changing the parameters of legally relevant measurement results, particularly for correction and calibration, shall be sealed in a manner that requires the security seal to be broken before an adjustment can be made to any component affecting the performance of an instrument.

The seals should, in all cases, be easily accessible. Securing should be provided on all parts of the measuring system which cannot be materially protected in any other way against operations liable to affect the measurement accuracy.

3.14.2 Means of securing

Securing shall be provided by hardware, passwords or similar software means provided that:

- a) Access shall only be allowed to authorised people, e.g. by means of a code (key-word) or of a special device (hard key, etc); the code must be changeable;
- b) It shall be possible for at least the last intervention to be memorised and it must be possible to access and display this information; the record shall include at least the ten most recent

access or changes, the date and a means of identifying the authorised person making the intervention (see (a) above); the traceability of the last intervention shall be assured for at least two years, if it is not over-written on the occasion of a further intervention; if it is possible to memorise more than one intervention, and if deletion of a previous intervention must occur to permit a new record, the oldest record shall be deleted.

- c) Software functions shall be secured against intentional, unintentional and accidental changes in accordance with the requirements of 3.13;
- d) Transmission of legally relevant data via interfaces shall be secured against intentional, unintentional and accidental changes in accordance with the requirements of 4.3.5.2;
- e) The securing possibilities available in an instrument shall be such that separate securing of the settings is possible;
- f) Stored data shall be secured against intentional, unintentional and accidental changes in accordance with the requirements of 3.6.

3.14.3 Adjustment

An instrument may be fitted with an automatic or a semi-automatic span adjustment device. This device shall be incorporated inside the instrument. External influence upon this device shall be practically impossible after securing.

3.15 Descriptive markings

Instruments and associated modules shall bear the following basic markings at each location having a mass indicating and recording device.

3.15.1 Markings shown in full

- identification mark and/or name of the manufacturer
 - identification mark and/or name of the importer (if applicable)
 - serial number
 - software identification
 - weighing method (see T.3.1)
 - maximum wagon mass kg or t
 - minimum wagon mass kg or t
 - not to be used to weigh liquid products (if applicable)
 - number of partial weighings per wagon (if applicable)
 - maximum transit speed (if applicable) km/h
 - direction of weighing (if applicable)
 - wagons pushed/pulled (whichever is applicable)
 - electric power supply voltage V
 - electric power supply frequency Hz
 - Temperature range (when not -10°C to 40°C)
- Deleted: <#>designation of the instrument¶
- Deleted: of the instrument (each load receptor, if applicable)
- Deleted: full draught or
- Deleted: <#>scale interval for stationary load (if applicable) kg or t¶

3.15.2 Markings shown in code

3.15.2.1 For all instruments

- type approval sign in accordance with national requirements
- accuracy class wagon mass (each weighing method, if applicable) 0.2, 0.5, 1 or 2

- maximum capacity
- minimum capacity
- scale interval
- maximum operating speed
- minimum operating speed

Max = kg or t
 Min = kg or t
 d = kg or t
 v_{max} = km/h
 v_{min} = km/h

3.15.2.2 For train weighing

Markings required for each weighing method applicable:

- maximum number of wagons per train
- minimum number of wagons per train

n_{max} =
 n_{min} =

3.15.3 Supplementary markings

Depending upon the particular use of the instrument, one or more supplementary markings may be required on type approval by the metrological authority issuing the type approval certificate.

3.15.4 Other markings

The designation of the liquid(s) which the instrument is designed to weigh (if applicable).

3.15.5 Presentation of descriptive markings

Descriptive markings shall be indelible and of a size, shape and clarity that permit legibility under normal conditions of use of the instrument.

Descriptive markings shall be shown in accordance with national legislation.

Markings shall be grouped together in a clearly visible place on the instrument, either on a descriptive plate fixed near the indicating device or on the indicating device itself.

It shall be possible to seal the plate bearing the markings, unless it cannot be removed without being destroyed.

The descriptive markings may be shown on a programmable display which is controlled by software provided that:

- At least Max, Min and d shall be displayed as long as the instrument is switched on.
- The other marking may be shown on manual commend.
- It must be described in the type approval (OIML) certificate

For programmable display means shall be provided for any access to reprogramming of the markings to be automatically and non-erasably recorded and made evident by an audit trail, e.g. by traceable access software such as an event logger providing a record of the changes.

When a programmable display is used, the plate of the instrument shall bear at least the following markings:

- type and designation of the instrument,

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- name or identification mark of the manufacturer,
- type approval number,
- electrical supply voltage,
- electrical supply frequency,
- pneumatic/hydraulic pressure, (if applicable).

3.16 Verification marks

3.16.1 Position

Instruments shall have a place for the application of verification marks. The following applies for this place:

- the part on which the marks are located cannot be removed from the instrument without damaging the marks;
- the place shall permit the easy application of the marks without changing the metrological qualities of the instrument;
- the marks shall be visible when the instrument is in service.

3.16.2 Mounting

Instruments required to bear verification marks shall have a verification mark support located as specified above, which shall ensure the conservation of the marks as follows:

- when the mark is made with a stamp, the support may consist of a material with malleable qualities (for example plastic, brass etc. depending on national regulation), inserted into a plate fixed to the instrument or a cavity bored into the instrument;
- when the mark consists of an adhesive transfer, a space shall be provided for this purpose.

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If self-adhesive stickers are used as verification marks the space for these stickers should have a diameter of at least 15 mm. These marks should be adequately durable for the intended use of the instrument, e.g. by means of a suitable protection.

4 TECHNICAL REQUIREMENTS FOR ELECTRONIC INSTRUMENTS

Electronic instruments shall comply with the following requirements, in addition to the applicable requirements of all other clauses.

4.1 General requirements

4.1.1 Rated operating conditions

Electronic instruments shall be designed and manufactured so that they do not exceed the maximum permissible errors under rated operating conditions.

Deleted: weighing

4.1.2 Disturbances

Electronic instruments shall be designed and manufactured so that when they are exposed to disturbances, either:

- a) significant faults do not occur, or
- b) significant faults are detected and acted upon.

Note: A fault equal to or less than the value specified in T.4.2.7 (1 d) is allowed irrespective of the value of the error of indication.

4.1.3 Durability

The requirements in 4.1.1 and 4.1.2 shall be met durably in accordance with the intended use of the instrument.

4.1.4 Evaluation for compliance

A type of an electronic instrument is presumed to comply with the requirements in 4.1.1, 4.1.2, and 4.1.3 if it passes the examination and tests specified in Annex A.

4.2 Application

4.2.1 The requirements in 4.1.2 may be applied separately to the following:

- a) each individual cause of significant fault, and/or
- b) each part of the electronic instrument.

The choice as to whether to apply 4.1.2 (a) or (b) is left to the manufacturer.

4.3 Functional requirements

4.3.1 Acting upon a significant fault

When a significant fault has been detected, a visual or audible indication shall be provided and shall continue until the user takes action or the fault disappears. Means shall be provided to retain any totalized load information contained in the instrument when a significant fault occurs.

4.3.2 Switch-on procedure

If the failure of an indicator display element can cause a false mass indication then the instrument shall have a display test facility which is automatically initiated at switch-on (in the case of electronic instruments permanently connected to the mains at switch-on of indication), e.g. indication of all the relevant signs of the indicator in their active and non-active states for a sufficient time to be easily observed by the operator. This is not applicable for non-segmented displays, on which failures become evident, for example screen-displays, matrix-displays, etc.

4.3.3 Influence factors

An electronic instrument shall comply with the requirements of 2.7, and in addition it shall maintain its metrological and technical characteristics at relative humidity of 85 % at the upper limit of the temperature range.

4.3.4 Warm-up time

During the warm-up time of an electronic instrument, there shall be no indication or transmission of the measurement result and automatic operation shall be inhibited.

Deleted: weighing

4.3.5 Interfaces

An instrument may be equipped with communication interfaces (T.2.8) permitting the coupling of the instrument to external equipment and user interfaces (T.2.9) permitting the exchange of information exchange between a human user and the instrument. When an interface is used, the instrument shall continue to function correctly and its metrological functions shall not be influenced.

4.3.5.1 Interface documentation

The manufacturer shall provide documentation on all interfaces comprising of at least:

- a) A list of all commands (e.g. menu items);
- b) Description of the software interface;
- c) A list of all commands together;
- d) A brief description of their meaning and their effect on the functions and data of the instrument.

4.3.5.2 Securing of interfaces

Communication and user interfaces shall not allow the legally relevant software and functions of the instrument and its and measurement data to be inadmissibly influenced by other interconnected instruments, or by disturbances acting on the interface.

An interface through which the functions mentioned above cannot be performed or initiated, need not be secured. Other interfaces shall be secured as follows:

- a) Data is protected (e.g. with a protective interface as defined in T.2.10) against accidental or deliberate interference during the transfer;
- b) All functions in the software interface shall be subject to the requirements for securing software in 3.13;
- c) All functions in the hardware interface shall be subject to the requirements for securing hardware in 3.14;
- d) Metrologically relevant parts of the target instrument shall be included in the initial verification (or equivalent conformity assessment procedures);
- e) it shall be easily possible to verify the authenticity and integrity of data transmitted to and from the instrument;
- f) Functions performed or initiated by other connected instruments through the interfaces shall meet the appropriate requirements of this OIML Recommendation.

Other instruments required by national regulation to be connected to the interfaces of an instrument shall be secured to inhibit automatically the operation of the instrument for reasons of the non-presence or improper functioning of the required device.

4.3.6 AC mains power

In the event of a power failure, the instrument shall retain the metrological information contained in the instrument at the time of failure for at least 24 hours. A switch-over to an emergency power supply shall not cause a significant fault.

4.3.7 DC mains or rechargeable battery power

An instrument that operates from auxiliary rechargeable battery or the DC mains voltage shall, whenever the voltage drops below the minimum operating voltage (2.7.2), either continue to function correctly or show an error message or is automatically put out of service.

4.4 Performance and span stability tests

4.4.1 Test considerations

All electronic instruments of the same category, whether or not equipped with checking facilities, shall be subjected to the same performance test programme as specified in Annex A to determine their correct functioning.

4.4.2 State of instrument under test

Performance tests shall be carried out on fully operational equipment in its normal operational state or in a status as similar as possible thereto. When connected in other than a normal configuration, the procedure shall be mutually agreed by the approval authority and the applicant and shall be described in the test document.

If an electronic instrument is equipped with an interface permitting the coupling of the instrument to external equipment, the instrument shall, during the tests A.7.3.2, A.7.3.3 and A.7.3.4, be coupled to external equipment, as specified by the test procedure.

4.4.3 Span stability tests

The instrument shall be subjected to span stability tests specified in A.8 at various intervals, before during and after being subjected to performance tests.

5 METROLOGICAL CONTROLS

The metrological controls of instruments shall, in agreement with national regulation, consist of the following:

- type evaluation;
- initial verification;
- subsequent verification
- in-service inspection.

Tests should be applied uniformly by the legal metrology services and should form a uniform program. Guidance for the conduct of type evaluation and initial verification is provided in OIML International Documents D 19 [8] and D 20 [9] respectively.

5.1 Type evaluation

5.1.1 Documentation

The application for type evaluation shall include documentation which provides the following information:

- metrological characteristics of the instrument;
- a standard set of specifications for the instrument;
- a functional description of the components and devices;
- drawings, diagrams and general software information (if applicable), explaining the construction and operation;
- any document or other evidence demonstrating that the design and construction of the instrument complies with the requirements of this Recommendation;
- operating manual.

5.1.2 General requirements

Type evaluation shall be carried out on at least one and normally, not more than three instruments that represent the definitive type. At least one of the instruments shall be completely installed at a typical site and at least one of the instruments or the major component of an instrument shall be submitted in a form suitable for simulation testing in a laboratory. Influence factors shall be applied during simulation tests in a manner that will reveal an alteration of the measurement result for any weighing process to which the instrument could be applied. The evaluation shall consist of the tests specified in 5.1.3.

5.1.3 Type evaluation tests

The submitted documents shall be examined and tests carried out to verify that the instruments comply with the:

- a) the metrological requirements in Clause 2, particularly with reference to maximum permissible errors and, if appropriate, when the instrument is operated in accordance with the manufacturer's specifications for products;
- b) the technical requirements in Clause 3.
- c) electronic instruments shall comply with the requirements in Clause 4.

The appropriate metrological authority shall:

- conduct the tests in a manner which prevents an unnecessary commitment of resources;
- permit the results of these tests to be assessed for initial verification when the same instrument is involved;
- ensure that an instrument used in static weighing in accordance with 6.2, comply with the requirements of 3.2.6.

Note: The appropriate metrological authority is advised to accept, with the consent of the applicant, test data obtained from other metrological authorities without repeating the tests.

5.1.3.1 Modules

Subject to agreement with the metrological authority, the manufacturer may define and submit modules to be examined separately. This is particularly relevant in the following cases:

- where testing the instrument as a whole is difficult or impossible;
- where modules are manufactured and/or placed on the market as separate units to be incorporated in a complete instrument;
- where the applicant wants to have a variety of modules included in the approved type;
- when a module is intended to be used for various kinds of weighing instruments (in particular load sensors, indicators, data storage).

5.1.3.1.1 Apportioning of errors

Where it is necessary to separately test modules of an instrument or system the following requirements apply.

The error limits applicable to a module which is examined separately are equal to a fraction p_i of the maximum permissible errors or the allowed variations of the indication of the complete instrument. The fractions for any module have to be taken for the same accuracy class as for the complete instrument incorporating the module.

The fractions p_i shall satisfy the following equation:

$$p_1^2 + p_2^2 + p_3^2 + \dots \leq 1$$

The fraction p_i shall be chosen by the manufacturer of the module and shall be verified by an appropriate test, taking into account the following conditions:

- For purely digital devices p_i may be equal to 0.
- For weighing modules p_i may be equal to 1.
- For all other modules (including digital load sensors) the fraction shall not exceed 0.8 and shall not be less than 0.3, when more than one module contributes to the effect in question.

For mechanical structures evidently designed and manufactured according to sound engineering practice, an overall fraction $p_i = 0.5$ may be applied without any test, e.g. when levers are made of the same material and when the chain of levers has two planes of symmetry (longitudinal and transversal).

If the metrological characteristics of the load sensor or other major component have been evaluated in accordance with the requirements of OIML R 60 [6], or any other applicable OIML Recommendation, that evaluation shall be used to aid type evaluation if so requested by the applicant.

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Deleted: ~~Note:~~ Since the requirements of this clause apply only to the instrument submitted for type evaluation and not to those subsequently submitted for verification, the means used to determine if the appropriate maximum permissible error or maximum allowable deviation has been exceeded will be decided and mutually agreed upon between the metrological authority and the applicant. Following are examples of these means: an adaptation of an indicating device or printer to give greater resolution than that of the scale interval;¶
<#>the use of the scale interval for stationary load;¶
<#>the use of weights of 1/10 d to determine the changeover point;¶
<#>any other means mutually agreed upon.¶

5.1.3.2 In-motion tests for type approval

A complete instrument shall be tested in accordance with the requirements in Clause 6, using the reference wagons specified in 6.3, under the rated operating conditions in accordance with the type specification. The errors shall be determined as specified in 5.1.3.3.

5.1.3.3 Evaluation of errors for automatic weighing

5.1.3.3.1 Wagon weighing

The error for automatic weighing for wagon mass shall be the recorded mass of the individual reference wagon (6.6) as appropriate, minus the conventional true value of the mass of the reference wagon (6.5) as appropriate. The MPE shall be as specified in 2.2.1.1 for initial verification as appropriate for the instrument.

5.1.3.3.2 Train weighing

The error for automatic train weighing shall be the recorded mass of the train, inclusive of all indicated mass of the individual reference wagons recorded as appropriate minus the conventional true value of the mass of the reference wagons (6.5) as appropriate. Each indicated wagon mass shall be used for assessing compliance with the maximum permissible errors in either 2.2.1.1 or 2.2.1.2, for initial verification as appropriate for the instrument.

5.1.4 Provision of means for testing

For the purposes of testing, the applicant may be required to furnish the metrological authority with the test vehicles, material, qualified personnel and a control instrument. The instrument under test may be used as a control instrument provided it complies with the requirements in 6.1.2.

5.1.5 Place of testing

Instruments submitted for type approval may be tested at the following places:

- on the premises of the metrological authority to which the application has been submitted, or
- in any other suitable place agreed between the metrological authority concerned and the applicant.

5.2 Initial verification

5.2.1 Tests

Instruments shall comply with the requirements in Clause 2 (except 2.7) and Clause 3 for any product(s) for which they are intended and when operated under normal conditions of use.

Tests shall be carried out by the appropriate metrological authority, in-situ, in a normal installation. The instrument shall be installed so that an automatic weighing operation will be virtually the same for testing as it is for a transaction.

Deleted: <#>a site at which all necessary tests can be conducted and agreed upon between the metrological authority and the applicant;¶
<#>a laboratory considered appropriate by the metrological authority;¶

The appropriate metrological authority shall conduct the tests in a manner that prevents an unnecessary commitment of resources. In appropriate situations and to avoid duplicating tests previously performed on the instrument for type evaluation under 5.1.3, the authority may use the results of observed tests for initial verification.

5.2.2 In-motion tests for initial verification

In-motion tests shall be conducted:

- in accordance with the descriptive markings (3.15).
- under the rated conditions for which the instrument is intended
- in accordance with the test methods in Clause 6, with the exception that the types of wagons and the number of wagons in the test train shall be in accordance with the normal operation of the instrument.

Deleted: for tests with coupled wagons,

5.2.3 Evaluation of errors for automatic weighing

The errors for automatic weighing shall be determined as specified in:

- a) 5.1.3.3.1 for individual wagons from wagon weighing;
- b) 5.1.3.3.2 for individual wagons or the train from train weighing.

5.2.4 Provision of means for testing

For the purposes of testing, the applicant may be required to furnish the metrological authority with the test vehicles, material, qualified personnel and a control instrument. The instrument under test may be used as a control instrument provided it comply with the requirements in 6.1.2.

5.2.5 Place of testing

Initial verification tests shall be conducted entirely at the place of installation and during testing, the instrument shall include all parts which form the assembly as intended for normal use.

5.3 Subsequent verification

Subsequent verification shall be carried out in accordance with the same provisions as in 5.2 for initial verification.

5.4 In-service inspection

In-service inspection shall be carried out in accordance with the same provisions as in 5.2 for initial verification, with the exception that the in-service maximum permissible errors shall be applied.

6.1 Control instrument for reference wagon weighing

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A control instrument for determining the conventional true value of each reference wagon mass, when stationary and uncoupled, shall be available for testing. The control instrument may be either separate or integral.

6.1.1 Separate control instrument

A control instrument, separate from the instrument being tested shall be available for in-motion tests. The error of that instrument shall not be greater than either one of the following values:

- one-third of the maximum permissible error for weighing-in-motion specified in 2.2.1 if the control instrument is verified immediately prior to the tests;
- one-fifth of the maximum permissible error if the control instrument is verified at any other time.

6.1.2 Integral control instrument (3.10)

The instrument under test may be used as the control instrument provided that it shall:

- ensure the determination of the conventional true value of each reference wagon mass by full-draught weighing when stationary and uncoupled to an accuracy of at least one-third of the maximum permissible error for weighing in motion specified in 2.2.1;
- have an appropriate scale interval or scale interval for stationary load (2.4);
- comply with the requirements in 3.10.

6.2 Static weighing test for integral control instruments

This test is applicable if the instrument being verified is to be used as the control instrument for measuring the static reference wagon mass.

6.2.1 Test weights

The reference standard weights or masses used for the type examination or verification of an instrument shall principally meet the metrological requirements of OIML R 111 [5]. The error of the additional weights used for in-motion tests shall exceed one-third of the maximum permissible errors of the instrument to be verified for the load, as specified in Table 3 for initial verification.

Errors shall be determined with test weights which results in mass values on the instrument of:

- near minimum wagon mass (T.3.1.5.1);
- near maximum wagon mass (T.3.1.5.2);
- at least two mass values in between a) and b).

Deleted: or near a load where the maximum permissible error changes.

6.2.2 Distribution of test weights

Except for eccentricity tests, standard weights shall be evenly distributed on the load receptor.

For testing control instruments for bogie partial weighing a special test vehicle with known mass shall be used. An example is a normal three-axle-bogie with a platform for the standard test weights.

6.2.3 Multiple load receptors

Each load receptor shall be tested by the static-weighing method both independently and in combination.

6.2.4 Eccentricity tests (A.5.2.3)

Large weights should be used in preference to several small weights. Smaller weights shall be placed on top of larger weights, but excessive stacking or overlapping of the weights on the load should be avoided within the segment of the load receptor to be tested provided that the conditions are practical and safe. The load shall be applied centrally in the segment if a single weight is used, but applied uniformly over the segment, if several small weights are used. It is sufficient to apply the load only to the eccentric segments, not to centre of the load receptor.

On installations where the weighed length is very short it may not be possible to apply this test fully. If so note the reduced load.

Note: If operating conditions are such that no eccentricity can occur, eccentricity tests need not be performed.

6.2.5 Substitution of standard test weights at verification

When testing instruments with $\text{Max} > 1 \text{ t}$, instead of standard test weights any other constant mass may be used, provided that standard test weights of at least 1 t or 50 % of Max, whichever is greater, are used. Instead of 50 % of Max, the portion of standard test weights may be reduced to:

- 35% of Max if the repeatability error is $\leq 0.3 \text{ d}$ (for in-motion tests),
- 20% of Max if the repeatability error is $\leq 0.2 \text{ d}$ (for in-motion tests).

The repeatability error has to be determined with a load of about the value where the substitution is made, by placing it 3 times on the load receptor.

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6.3 Reference wagons

The reference wagons to be used for testing shall represent the range of wagons available in the appropriate Member State and for which the instrument is intended. The reference wagons shall be selected to cover, as far as practicable, the weighing range for which the instrument is approved.

Where a particular instrument is tested using a limited range of wagon types this should be noted in the OIML certificate.

Wagons carrying liquid loads or other products that may be subjected to fluctuations in its gravity centre when the wagon moves, shall be used as reference wagons only if the weigh-in-motion instrument will be applied subsequently for determining the mass of such wagons. If the instrument is not intended for this use, it shall bear the marking “not to be used to weigh wagons carrying liquids or other products that that may be subjected to fluctuations in its gravity centre with vehicle movement”

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6.3.1 Uncoupled wagon in-motion weighing

A minimum of five single reference wagons with a range of loads from zero-load (unloaded) to a fully loaded wagon shall be used for assessing compliance with the requirements in 5.1.3.2.

6.3.2 Coupled wagon or train in-motion weighing

Normally all the wagons in a test train shall be weighed, thus becoming reference wagons n_{ref}

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There shall be two test trains, one containing empty reference wagons and the other containing full and partially loaded reference wagons. Each test train shall be weighed repeatedly and in each direction (if applicable) to yield not less than four mass indications for each reference wagon in the train.

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Where the test train may not contain only reference wagons, the number of reference wagons may be reduced taking into consideration the limits given in Table 4. If the number of reference wagons is less than the total number of wagons in a test train, the reference wagons shall be distributed throughout the train.

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Each of the two test trains should contain approximately the maximum number of wagons n_{max}

Where the accuracy class of the train is higher than that of the wagons, a supplementary test train containing the minimum number n_{min} of wagons should be used.

Table 4

Proportion of reference wagons in a test train	
Total number of wagons in test train (n)	Minimum number of reference wagons
<u>$n \leq 10$</u>	<u>n</u>
10 < n ≤ 30	10
30 < n	15

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6.4 **Number of in-motion tests**

Each reference wagon shall undergo a minimum of four test runs conducted at operating speeds (A.9.3.3.1) that are within the range of speeds for which the instrument is to be evaluated.

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6.5 Conventional true value of the mass of reference wagons

The conventional true value of each reference wagon mass normally shall be determined by full draught weighing on a suitable control instrument, as detailed in A.9.3.1.1.

If there is no suitable control instrument for full-draught weighing available with an acceptable accuracy or scale of suitable length, or in an acceptable distance (see A.9.2) a control instrument for bogie partial weighing (separate or integral) may be used, as detailed in A.9.3.1.2.

6.6 Recorded mass of reference wagons during in-motion wagon weighing

The indication of the mass of the reference wagons following an automatic weighing operation shall be recorded. The procedures of A.3.5 shall be used to eliminate the rounding errors included in any digital indication and measurement of the weighing results.

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Deleted: 6.8 Mean values of the reference wagon mass¶

¶ The mean value for a reference wagon mass shall be the sum of the indicated or printed mass values obtained for a reference wagon during an in-motion test, divided by the number of values for that reference wagon.¶

ANNEX A (Mandatory)

TEST PROCEDURES FOR AUTOMATIC RAIL-WEIGHBRIDGES

A.1 EXAMINATION FOR TYPE APPROVAL

A.1.1 Documentation (5.1.1)

Review the documentation that is submitted, including necessary photographs, drawings, diagrams, general software information, relevant technical and functional description of main components, devices etc. to determine if it is adequate and correct. Consider the operational manual.

A.1.2 Comparing construction with documentation (5.1.1)

Examine the various devices of the instrument to ensure compliance with the documentation.

A.1.3 Technical requirements (3)

Examine the instrument for conformity with the technical requirements according to the checklist given in the test report format in OIML R 106-2.

A.1.4 Functional requirements (4.3 and 4.4)

Examine the instrument for conformity with the functional requirements according to the checklist given in the test report format in OIML R 106-2.

A.2 EXAMINATION FOR INITIAL VERIFICATION

A.2.1 Compare construction with documentation (5.2)

Examine the instrument for conformity with the approved type.

A.2.2 Metrological characteristics

Note metrological characteristics according to the checklist given in the test report format in OIML R 106-2.

A.2.3 Descriptive markings (3.15)

Check the descriptive markings according to the requirements in 3.15 and the type approval documents.

A.2.4 Verification marks (3.16) and securing devices (3.14)

Check the arrangements for verification marks and securing according to the checklist given in the test report format in OIML R 106-2.

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A.3 GENERAL TEST CONDITIONS

A.3.1 Power supply

Power-up the equipment under test (EUT) for a time period equal to or greater than the warm-up time specified by the manufacturer and maintain the EUT energised for the duration of each test.

A.3.2 Zero-setting

Adjust the EUT as closely as practicable to zero prior to each test, and do not readjust it at any time during the test, except to reset it if a significant fault has occurred.

Certain tests require the automatic zero-setting and zero-tracking devices to be in operation (or not in operation). Where there is no specific requirement to this effect, the automatic zero-setting and zero-tracking devices shall be switched-off. When this is done it shall be mentioned in the test report.

A.3.3 Temperature

The tests shall be performed at a steady ambient temperature, usually normal room temperature unless otherwise specified. The temperature is deemed to be steady when the difference between the extreme temperatures noted during the test does not exceed one-fifth of the temperature range of the instrument without being greater than 5 °C and the rate of change does not exceed 5 °C per hour.

Deleted: Note that this requirement does not apply to in-motion tests

The handling of the instrument shall be such that no condensation of water occurs on the instrument.

During the tests on site, the weather shall not be too windy, stormy, rainy or snowy.

A.3.4 Recovery

After each test, allow the instrument to recover sufficiently before the following test.

A.3.5 Evaluation of error in non-automatic (static) operation

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A.3.5 Preloading Before each weighing test the instrument shall be pre-loaded to Max, except for the tests in A.6.1 and A.7.2.2.¶

A.3.5.1 Indication with a scale interval of 0.2 d or less.

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If an instrument with digital indication has a device for displaying the indication with a scale interval of 0.2 d or less, this device may be used to calculate the error. If a device is used it should be noted in the test report.

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A.3.5.2 Use of reference standard weights to assess rounding error

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Where necessary, additional weights, meeting the requirements in 6.3 may be used to assess the rounding error.

A.3.5.2.1 General method to assess error prior to rounding

For instruments with digital indication having a scale interval d , changeover points may be used to interpolate between scale intervals, i.e. to determine the indication of the instrument, prior to rounding, as follows:

At a certain load, L , the recorded value, I , is noted. Additional weights of about $0.1 d$ are successively added until the indication of the instrument is increased unambiguously by one scale interval ($I + d$). The additional load ΔL added to the load receptor gives the indication, P , prior to rounding by using the following formula:

$$P = I + 0.5 d - \Delta L$$

The error prior to rounding is:

$$E = P - L = I + 0.5 d - \Delta L - L$$

Example: an instrument with a scale interval, d , of 10 kg is loaded with 1000 kg and thereby indicates 1000 kg. After adding successive weights of 1 kg, the indication changes from 1000 kg to 1010 kg at an additional load of 3 kg. Inserted in the above formula these observations give:

$$P = (1000 + 5 - 3) \text{ kg} = 1002 \text{ kg}$$

Thus the true indication prior to rounding is 1002 kg, and the error is:

$$E = (1002 - 1000) \text{ kg} = 2 \text{ kg}$$

A.3.5.2.2 Correction for error at zero

Evaluate the error at zero load, (E_0) by the method of A.3.6.2.1.

Evaluate the error at load L , (E) by the method of A.3.6.2.1.

The corrected error prior to rounding, (E_c) is:

$$E_c = E - E_0$$

Example: if, for the example in A.3.5.2.1, the error calculated at zero load was:

$$E_0 = + 1 \text{ kg},$$

The corrected error is:

$$E_c = + 2 - (+ 1) = + 1 \text{ kg}$$

A.4. TEST PROGRAM

A.4.1 Type evaluation (5.1)

Clauses A.1, and A.6 to A.9 shall normally be applied for type evaluation.

Sub-clause A.5.2 may be omitted if the instrument under test is not an integral control instrument.

The tests for clauses A.6 to A.8 shall be performed with static load, a wheel movement simulator (switches) may be used if necessary for the calculation of the measurement results.

A.4.2 Initial verification (5.2)

Clauses A.2 and A.9 shall be applied for initial verification.

If the instrument under test is to be used as an integral control instrument the tests in Sub-clause A.5.2 shall also be applied.

The test shall include all dynamic in-motion effects corresponding to normal operation of the instrument.

A.5 PERFORMANCE TESTS DURING TYPE EVALUATION

A.5.1 Zero-setting (3.3)

A.5.1.1 Range of zero-setting

A.5.1.1.1 Initial zero-setting

The initial zero-setting range is the sum of the positive and negative portions of the initial zero-setting range. If the load receptor cannot readily be removed, only the positive part of the initial zero-setting range need be considered.

(a) Positive range

With the load receptor empty, set the instrument to zero. Place a test weight on the load receptor and switch the instrument off and then back on. Continue this process until, after placing weights on the load receptor and switching the instrument off and on, it does not reset to zero. The maximum weight that can be re-zeroed is the positive portion of the initial zero-setting range.

(b) Negative range

Remove any weights from the load receptor and set the instrument to zero. Then remove the load receptor (platform) from the instrument. If, at this point, the instrument can be reset to zero by switching it off and back on, the mass of the load receptor is used as the negative portion of the initial zero-setting range.

If the instrument cannot be reset to zero with the load receptor removed, add weights to any live part of the scale (e.g. on the parts where the load receptor rests) until the instrument indicates zero again.

Then remove weights and, after each weight is removed, switch the instrument off and

back on. The maximum load that can be removed while the instrument can still be reset to zero by switching it off and on is the negative portion of the initial zero-setting range.

A.5.1.1.2 Semi-automatic zero-setting

This test shall not be carried out during the span stability test.

This test is performed in the same manner as described in A.5.1.1.1, except that the zero-setting device is used rather than switching the instrument on and off.

A.5.1.1.3 Automatic zero-setting

This test shall not be carried out during the span stability test.

Remove the load receptor (platform) as described in A.5.1.1.1 and place weights on the instrument until it indicates zero.

Remove weights in small amounts and after each weight is removed allow the instrument to operate through the appropriate part of the automatic cycle so as to see if the instrument is reset to zero automatically. Repeat this procedure until the instrument will not reset to zero automatically.

The maximum weight that can be removed so the instrument can still be reset to zero is the zero-setting range.

If the load receptor cannot readily be removed, a practical approach can be to add weights to the instrument and use another zero-setting device, if provided, to set the instrument to zero. Then remove weights and check whether the automatic zero-setting still sets the instrument to zero. The maximum weights that can be removed so that the instrument can still be reset to zero is the zero-setting range.

A.5.1.2 Accuracy of zero-setting

A.5.1.2.1 Semi-automatic zero-setting

The accuracy of the zero-setting device is tested by setting the instrument to zero and then determining the additional load at which the indication changes from zero to one scale interval above zero. The error at zero is calculated according to the description in A.3.5.2.1.

A.5.1.2.2 Automatic zero-setting or zero-tracking

The indication is brought outside of the automatic range (e.g. by loading with 10 d). Then the additional load at which the indication changes from one scale interval to the next above is determined and the error is calculated according to the description in A.3.5.2.1. It is assumed that the error at zero load would be equal to the error at the load in question.

A.5.1.3 Setting to zero before loading

For instruments with digital indication, the adjustment to zero or the determination of the zero point is carried out as follows:

- a) for instruments with non-automatic zero-setting, weights equivalent to half a scale interval are placed on the load receptor, and zero-setting is adjusted until the indication alternates between zero and one scale interval. Then weights equivalent to half a scale interval are removed from the load receptor to attain a centre of zero reference position;
- b) for instruments with semi-automatic or automatic zero-setting, the deviation from zero is determined as described in A.5.1.2.

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A.5.2 Non-automatic tests of the integral control instrument (3.10)

This sub-clause is only applicable to instruments which are to be used as a control instrument for static weighing. The tests are performed on the control instrument in-situ at the time of type approval or verification.

A.5.2.1 Zero-setting

A.5.2.1.1 Accuracy of zero-setting (3.3.1)

Determination of the accuracy of zero setting is carried out as described in A.5.1.2.1 or A.5.1.2.2, as appropriate.

A.5.2.2 Determination of weighing performance

A.5.2.2.1 Preloading

Before the first weighing test the instrument shall be preloaded once to Max.

A.5.2.2.2 Static weighing test (6.2)

Apply test loads from zero up to and including Max, and then remove the test loads back to zero. When determining the initial intrinsic error, at least ten different load values are selected, and for other weighing tests at least five are selected. The test loads selected shall include values near maximum and near minimum wagon weights, and at least two load values in between the maximum and minimum wagon weights.

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It should be noted that when loading or unloading weights the load must be respectively increased or decreased in a uniform progression.

If the instrument is provided with automatic zero-setting or zero-tracking device it may be in operation during the test, in which case the error at zero point shall be determined according to A.5.1.2.2.

The maximum permissible error shall be the appropriate values from clause 2.2.2 for initial verification.

A.5.2.3 Eccentricity test (6.2.4)

On an instrument with a load receptor having n points of support with $n \leq 4$, the fraction $1/n$ of Max shall applied to each point of support.

A load shall be applied at different positions on the load receptor. These positions shall be at the beginning, the middle and at the end of the load receptor in the normal driving direction. The positions shall then be repeated in the reverse direction, if the application in both directions is possible. Before changing direction zero has to be determined again. If the load receptor consists of several sections, the test shall be applied to each section.

The location of the load shall be marked on a sketch in the test report.

The error value at each measurement is determined according to A.3.5.1.1. The zero error E_0 used for the correction is the value determined prior to each measurement.

The errors shall not exceed the appropriate maximum permissible errors from 2.2.2 for initial verification.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall not be in operation during the eccentricity tests.

Note: If operating conditions are such that no eccentricity can occur, eccentricity tests need not be performed.

.A.5.2.4 Discrimination test (3.10.1.3 and 3.10.24)

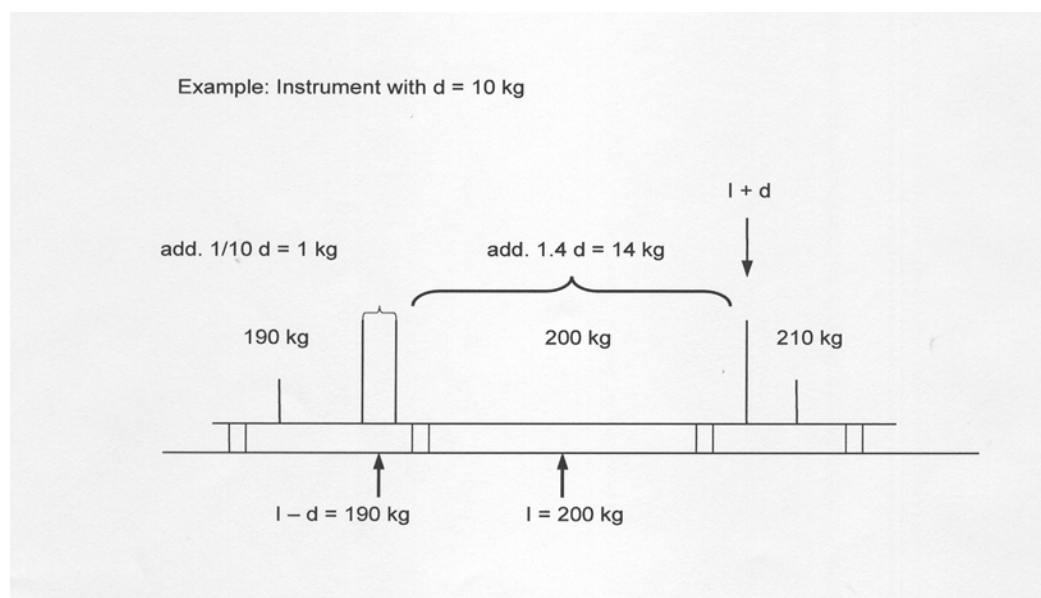
This test applies only to type examination.

The following tests are performed with three different loads, e.g. Min, 0.5 Max and Max.

A load plus sufficient additional weights (i.e. 10 times $1/10 d$) shall be placed on the load receptor. The additional weights shall then be removed successively until the indication, I , is decreased unambiguously by one actual scale interval, $I - d$. One of the additional weights shall be placed back on the load receptor and a load equal to $1.4 d$ shall then be gently placed on the load receptor and give a result increased by one actual scale interval above the initial indication, $I + d$. See example in Figure 3.

The indication at the start is $I = 200$ kg. Remove additional weights until the indication changes to $I - d = 190$ kg. Add $1/10 d = 1$ kg and thereafter $1.4 d = 14$ kg. The indication shall then be $I + d = 210$ kg.



Figure 3



A.5.2.5 Repeatability test (3.10.1.4 and 3.10.2.5)

Two series of weighings shall be performed, one with weight of about 50 % and one with weight close to 100 % of Max. Each series shall consist of at least three weighings. Readings shall be taken when the instrument is loaded, and when the unloaded instrument has come to rest between weighings. In the case of a zero deviation between the weighings, the instrument shall be reset to zero, without determining the error at zero. The true zero position need not be determined between the weighings.

If the instrument is provided with automatic zero-setting or zero-tracking, it shall be in operation during the test.

For verification one series of weighings with about 0.8 Max is sufficient. Three weighings on classes  and .

A.6 ADDITIONAL FUNCTIONALITY

A.6.1 Warm-up time test (4.3.4)

This test is to verify that metrological performance is maintained in the period immediately after switch on. The method is to check that automatic operation is inhibited until a stable indication is

obtained and to verify that zero and span errors comply with the requirements during the first 30 minutes of operation.

- (1) Disconnect the instrument from the power supply for a period of at least 8 hours prior to the test.
- (2) Reconnect the instrument and switch on while observing the indicating device.
- (3) Verify that it is not possible to initiate automatic weighing or recording until the indication has stabilised or until completion of the warm-up time if it is specified by the manufacturer (4.3.4).
- (4) As soon as the indication of the indicating device has stabilised, set the instrument to zero if this is not done automatically
- (5) Determine the error of zero-setting by the method of A.3.6.2.1 and record this error as E_{0i} (error of initial zero-setting) at first and as E_0 when repeating this step.
- (6) Apply a load close to Max. Determine the error by the method of A.3.6.2.1 and A.3.6.2.2.
- (7) Verify that:
 - zero indication error (E_{0i}) is not greater than $0.25 d$ (3.3.1)
 - span error is not greater than the maximum permissible error specified in 2.2.2 for initial verification.
- (8) Repeat stages (5) and (6) after 5, 15 and 30 minutes.
- (9) After each time interval verify that:
 - zero variation error ($E_0 - E_{0i}$) is not greater than $0.25 d \cdot p_i$,
 - span error is not greater than the maximum permissible error specified in 2.2.2 for initial verification.

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Other test methods which verify that metrological performance is maintained during the first 30 minutes of operation may be used.¶

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A.6.2 Agreement between indicating, recording and printing devices (2.9)

During the course of the tests verify that for the same load, the difference between any two indicating devices having the same scale interval is as follows:

- zero for digital indicating, recording or printing devices;
- not greater than the maximum permissible error for weighing-in-motion for analogue devices.

A.6.3 Operating speed (3.4.5.3 and A.9.4)

Verify that the automatic indication and recording of the operating speed contain a clear warning message if the speed is outside the specified range.

A.6.4 Functionality under the minimum operating voltage (4.3.7)

Reduce voltage supply until the instrument ceases to operate or ceases to give a weight indication. Verify that no malfunction or significant fault occurs before the instrument is thus put out of service. Measure and record the voltage value when the instrument ceases to operate or ceases to give a weight indication and compare this measured value with the manufacturer's

specified value.

A.7 INFLUENCE FACTOR AND DISTURBANCE TESTS

A.7.1 Test conditions

A.7.1.1 General requirements

Instruments for wagon and train weighing shall comply with the influence factor and disturbance tests conditions and requirements specified in this Annex.

Influence factor and disturbance tests are intended to verify that instruments can perform and function as intended in the environment and under the conditions specified. Each test indicates, where appropriate, the reference condition under which the intrinsic error is determined.

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It is not possible to apply these tests to an instrument that is performing an automatic operation. The instrument shall therefore be subjected to the influence factors and disturbances under static conditions or simulated operation as defined herein. The permissible effects of the influence factors or disturbances, under these conditions, are specified for each case.

When the effect of one influence factor is being evaluated, all other factors are to be held relatively constant, at a value close to normal. After each test the instrument shall be allowed to recover sufficiently before the following test.

Where modules of the instrument are examined separately, errors shall be apportioned in accordance with 5.1.3.1.1.

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The operational status of the instrument or simulator shall be recorded for each test.

When an instrument is connected in other than a normal configuration, the procedure shall be mutually agreed on by the approving authority and the applicant.

Deleted: The simulator for influence factor and disturbance tests should include all electronic devices of the weighing system including a:¶

¶ weight simulator;¶
train wheel simulator.A.7.1.2.2 Weight simulator¶

A.7.1.2 Using a simulator to test modules.

A.7.1.2.1 General

If a simulator is used to test a module, the repeatability and stability of the simulator should make it possible to determine the performance of the module with at least the same accuracy as when a complete instrument is tested with weights, the MPE to be considered being those applicable to the module. The simulator must be capable of providing a minimum input signal, $\mu\text{V/d}$ (normally minimum input voltage) per (scale interval).

¶
For practical reasons, the weight simulator may take various forms. For example, it may be a weigh pan or platform scale of approximately $1/1000^{\text{th}}$ of the weight range of a site installation, or a load cell simulator. Whichever method is adopted, it must be independently calibrated and readable to at least $0.1 d$. The simulator must be capable of providing a minimum input signal, $\mu\text{V/d}$ (normally minimum input voltage) per (scale interval). $\mu\text{V/d}$.¶

If a simulator is used, this shall be noted in the test report and its traceability referenced.

¶
The weight simulator shall be adequate for train movement simulation and capable of providing the signals from track switches, or other vehicle type identification devices, normally transmitted when a vehicle passes over the weighing system. ¶

A.7.1.2.2 Interfaces (4.3.5)

Susceptibility that would result from the use of electronic interfaces to other equipment shall be simulated in the tests. For this purpose it is sufficient to connect 3 m of interface cable terminated to simulate the interface impedance of the other equipment.

A.7.1.2.3 Documentation

Simulators shall be defined in terms of hardware and functionality by reference to the instrument under test, and by any other documentation necessary to ensure reproducible test conditions. This information shall be attached to, or traceable from, the test report.

A.7.2 Influence factor tests

Summary of tests

Test	Criteria	§
Static temperatures	MPE ^(*)	A.7.2.1
Temperature effect on no load indication	MPE	A.7.2.2
Damp heat, steady state test	MPE	A.7.2.3
AC mains <u>power</u>	MPE	A.7.2.4
DC mains <u>power</u>	MPE	A.7.2.5
<u>Auxiliary batteries (re)chargeable during the operation of the instrument</u>	MPE	A.7.2.6

(*) maximum permissible errors as specified in 2.2.2 Table 3

A.7.2.1 Static temperature tests (2.7.1.1)

Static temperature tests are carried out according to basic standard IEC Publication 60068-2-1 [10], IEC Publication 60068-2-2 [11] and IEC 60068-3-1 [12], and according to Table 4.

Table 4 -Static temperature test

Table 1: Static temperature test		
Environmental Phenomena	Test specification	Test set-up
Temperature	Reference temperature of 20 °C	IEC 60068-2-2 IEC 60068-2-1 IEC 60068-3-1
	Specified high temperature for 2 hours	
	Specified low temperature for 2 hours	
	Temperature of 5 °C, if the specified low temperature is ≤ 0 °C	
	Reference temperature of 20 °C	
Notes: Use IEC 60068-3-1 for background information. The static temperatures test is considered as one test.		

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 4.1.1 under conditions of dry heat (non-condensing) and cold. The test in A.7.2.2 may be conducted during this test.

Test procedure in brief:	The test consists of exposure of the EUT to a steady ambient temperature within the range stated in 2.7.1.1.
Preconditioning:	16 hours
Condition of the EUT:	EUT is connected to the voltage supply and «on» for a time period equal to or greater than the warm-up time specified by the manufacturer. Voltage supply is to be «on» for the duration of the test. The zero-setting and zero-tracking facilities shall be enabled as for normal operation. If the test is performed together with A.7.2.2 automatic zero-setting and zero tracking shall not be in operation.
Stabilisation:	2 hours at each temperature under «free air» conditions. «Free air» conditions mean a minimum air circulation to keep the temperature at a stable level.
Temperature:	As specified in 2.7.1.1
Temperature sequence:	<ul style="list-style-type: none"> a) at the reference temperature of 20 °C b) at the specified high temperature, c) at the specified low temperature, d) at a temperature of 5 °C, if the specified low temperature is below 10 °C, and e) at the reference temperature
Barometric pressure	Changes in barometric pressure shall be taken into account.
Number of test cycles:	At least one cycle.
Test information:	<p>Adjust the EUT as close to zero indication as practicable prior to the test (if an automatic zero-tracking device is connected, adjust it to a value near zero). The EUT shall not be readjusted at any time during the test.</p> <p>After stabilisation at the reference temperature and again at each specified temperature, apply at least five different test loads or simulated loads and record:</p> <ul style="list-style-type: none"> a) date and time; b) temperature; c) relative humidity; d) test load; e) indications (as applicable); f) errors; g) functional performance.
Maximum allowable variations:	All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 for initial verification.

A.7.2.2 Temperature effect on the no-load indication (2.7.1.2)

No reference to international standards can be given at the present time. This test should therefore be conducted as described below.

This test does not need to be performed for instruments that have automatic zero setting as part of every automatic weighing cycle.

The instrument is set to zero, the temperature is then changed from 20 °C to the prescribed highest and lowest temperature, to 5 °C and to reference 20 °C. After stabilization the error of the zero indication is determined at each temperature level. The change in zero indication per 5 °C is calculated. The changes of these errors are calculated for any two consecutive temperatures of this test.

This test shall be performed together with the temperature test (A.7.2.1). The errors at zero shall then be additionally determined immediately before changing to the next temperature and after the 2-hour period after the instrument has reached stability at this temperature.

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Note: Pre-loading is not allowed before these measurements.

Automatic zero-setting or zero-tracking if available, shall not be in operation.

Maximum allowable variations: The change in zero indication shall not vary by more than one scale interval for a temperature difference of 5 °C.

Condition of EUT: Normal power «on» for a time period equal to or greater than the warm-up time specified by the manufacturer. Power is to be «on» for the duration of the test.

A.7.2.3 Damp heat, steady-state (4.3.3)

Damp heat, steady state tests are carried out according to basic standard IEC Publication 60068-2-78 [13] and IEC Publication 60068-3-4 [14] and according to Table 5.

Table 5 - Damp heat, steady state test

Environmental phenomena	Test specification	Test set-up
Damp heat, Steady state.	Upper limit temperature and relative humidity of 85% for 48 hours.	IEC 60068-2-78 IEC 60068-3-4
Note: Use IEC 60068-3-4 for guidance for damp heat tests.		

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 4.1.1 under conditions of high humidity and constant temperature.

Test procedure in brief:

Preconditioning: None required.

Condition of the EUT:	EUT is connected to the voltage supply and «on» for a time period equal to or greater than the warm-up time specified by the manufacturer. The zero-setting and zero-tracking facilities shall be enabled as for normal operation.
	The handling of the EUT shall be such that no condensation of water occurs on the EUT.
Stabilisation:	3 hours at reference temperature and 50 % humidity. 2 days at the upper limit temperature as specified in 2.7.1.1.
Temperature:	Reference temperature (20 °C or the mean value of the temperature range whenever 20 °C is outside this range) and at the upper limit as specified in 2.7.1.1.
Temperature-humidity 48 hour sequence:	(a) Reference temperature of 20 °C at 50 % humidity; (b) Upper limit temperature at 85 % humidity; (c) Reference temperature of 20 °C at 50 % humidity.
Barometric pressure:	Changes in barometric pressure shall be taken into account.
Number of test cycles:	At least one cycle.
Test information:	After stabilisation of the EUT at reference temperature and 50 % humidity, apply at least five different test loads or simulated loads and record: <ul style="list-style-type: none"> a) date and time; b) temperature; c) relative humidity; d) test load; e) indications (as applicable); f) errors; g) functional performance. <p>Increase the temperature in the chamber to the upper limit and increase the relative humidity to 85 %. Maintain the EUT at no load for a period of 48 hours. Following the 48 hours, apply the same test loads or simulated loads and record the data as indicated above.</p> <p>Decrease the relative humidity to 50 % and decrease the temperature in the chamber to the reference temperature. After stabilisation of the EUT, apply the same test loads or simulated loads and record the data as indicated above.</p> <p>Allow full recovery of the EUT before any other tests are performed.</p>
Maximum allowable variations:	All errors shall be within the maximum permissible errors specified in 2.2.2 for initial verification.

A.7.2.4 AC mains power (2.7.2, 4.3.6)

AC mains voltage supply variation tests are carried out according to basic standard IEC Publication 61000-2-1 [15] and IEC Publication 61000-4-1 [16], and according to Table 6.

Table 6 - AC mains voltage

Environmental phenomena	Test specification	Test set-up
AC mains voltage supply variation	U_{nom}	IEC 61000-2-1 IEC 61000-4-1
	Upper limit: $1.10 \times U_{nom}$ or $1.10 \times U_{max}$	
	Lower limit: $0.85 \times U_{nom}$ or $0.85 \times U_{min}$	
	U_{nom}	
Note.	Where an instrument is powered by a three phase supply, the voltage variations shall apply for each phase successively	

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 4.1.1 under conditions of AC mains voltage variations.

Test procedure in brief:

Preconditioning: None required.

Condition of the EUT: EUT is connected to the AC mains supply and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable prior to the test and do not readjust at anytime during the test except to reset if a significant fault has occurred.

Number of test cycles: At least one cycle.

Test information: The EUT shall be tested with a test or simulated load at or near Min and with one test load or simulated load between 50 % and the maximum capacity of the EUT.

Stabilize the EUT at the nominal voltage and record the following data:

- a) date and time;
- b) temperature;
- c) relative humidity;
- d) AC voltage supply;
- e) test loads;
- f) indications (as applicable);
- g) errors;
- h) functional performance.

Repeat the test for each of the voltages defined in IEC 61000-4-1, section 5 (noting the need in certain cases that the weighing test will be repeated at both ends of the voltage range) and record the

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indications.

Maximum allowable variations:

All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 for initial verification.

A.7.2.5 DC mains power (2.7.2)

Instruments operating from DC mains voltage supply shall fulfil the tests in A.7.2, with the exception of A.7.2.4 which is to be replaced by the test according to basic standard IEC Publication 60654-2 [17] and according to Table 7.

Table 7 – DC mains power

Environmental phenomena	Test specification	Test set-up
DC mains voltage variations	U_{nom}	IEC 60654-2
	Upper limit: $1.20 \times U_{nom}$ or $1.20 \times U_{max}$	
	Lower limit: minimum operating voltage (see 2.7.2)	
	U_{nom}	
Note: In case a voltage-range is marked, use the average value as nominal U_{nom}		

Supplementary information to the IEC test procedures:

Object of the test: To verify compliance with the provisions in 4.1.1 under conditions of DC mains voltage variations

Test procedure in brief: The test consists of exposure to the specified voltage supply condition for a period sufficient for achieving temperature stability and for performing the required measurements.

Pre-condition: None

Condition of the EUT: EUT is connected to the DC mains voltage supply and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test and do not readjust at any time during the test except to reset if a significant fault has occurred.

Number of test cycles: At least one cycle.

Test information: Stabilize the EUT at the nominal voltage and record the following data at no load and with one load or simulated load:

- a) date and time;
- b) temperature;
- c) relative humidity;
- d) DC voltage supply;
- e) test loads;
- f) indications (as applicable);
- g) errors;

h) functional performance.

Repeat the test for each of the voltages defined in IEC 60654-2 and record the indications.

Maximum allowable variations:

All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 for initial verification.

A.7.2.6 Auxiliary batteries (re)chargeable during the operation of the instrument (2.7.2 and 4.3.7)

Instruments powered by rechargeable auxiliary batteries that are intended to be (re)charged during the operation of the instrument shall fulfil the tests in A.7.2, in accordance with Table 7.

Table 7 – Rechargeable auxiliary batteries

Environmental phenomena	Test specification	Test set-up
Voltage variations of rechargeable auxiliary batteries that are intended to be (re)charged during the operation of the instrument	U_{nom}	No reference to standards for this test.
	<u>Upper limit:</u> $1.10 \times U_{nom}$ or $1.10 \times U_{max}$	
	<u>Lower limit:</u> <u>minimum operating voltage (see 2.7.2)</u>	
	U_{nom}	
<u>Note:</u> <u>Rechargeable auxiliary batteries shall comply with the requirements for AC mains powered instrument with the mains power switched on.</u>		

Supplementary test information:

Object of the test: To verify compliance with the provisions in 4.1.1 under conditions of low voltage variations of rechargeable auxiliary batteries that are intended to be (re)charged during the operation of the instrument.

Test procedure in brief: The test consists of exposure to the specified condition of the battery for a period sufficient for achieving temperature stability and for performing the required measurements.

Pre-condition: None

Condition of the EUT EUT is connected to the battery power and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test and do not readjust at any time during the test except to reset if a significant fault has occurred.

Number of test cycles: At least one cycle.

Test information: Stabilize the EUT at the nominal voltage and record the following data at no load and with one load or simulated load:

a) date and time;

- b) temperature;
- c) relative humidity;
- d) battery voltage supply;
- e) test loads;
- f) indications (as applicable);
- g) errors;
- h) functional performance.

Reduce the voltage to the EUT until the instrument ceases to function properly according to the specifications and metrological requirements, and record the indications

Maximum allowable variations:

All functions shall operate as designed. All errors shall be within the maximum permissible errors specified in 2.2.2 for initial verification.

A.7.3 Disturbance tests (4.1.2)

Summary of tests

<u>Test</u>	<u>Criteria</u>	<u>§</u>
<u>AC mains voltage short time power reduction</u>	<u>sf ^(*)</u>	<u>A.7.3.1</u>
<u>Electrical fast transients/burst immunity on mains supply lines and on I/O circuits and communication lines</u>	<u>sf</u>	<u>A.7.3.2</u>
<u>Electrical surges on mains supply lines and on I/O circuits and communication lines</u>	<u>sf</u>	<u>A.7.3.3</u>
<u>Electrostatic discharges</u>	<u>sf</u>	<u>A.7.3.4</u>
<u>Immunity to electromagnetic fields</u>	<u>sf</u>	<u>A.7.3.5</u>

^(*) value of the significant fault (see T.4.2.7)

Prior to any test, the rounding error shall be set as close as possible to zero.

If there are interfaces on the instrument (or simulator), the use of these interfaces to other equipment shall be simulated in the tests. For this purpose, either an appropriate peripheral device or 3 m of interface cable to simulate the interface impedance of the other equipment, shall be connected to each different type of interface.

A.7.3.1 AC mains power short time power reduction

AC mains voltage short time power reduction (voltage dips and short interruptions) tests are carried out according to basic standard IEC Publication 61000-4-11 [18] and according to Table 11.

Table 14- Short time power reductions

Environmental phenomena	Test specification			Test set-up
Voltage dips and short interruptions	Test	Reduction of amplitude to	Duration / Number of cycles	IEC 61000-4-11
	Test a	0 %	0.5	
	Test b	0 %	1	
	Test c	40 %	10	
	Test d	70 %	25/30 ⁽²⁾	
	Test e	80 %	250/300 ⁽²⁾	
	Short interruption	0 %	250 ⁽²⁾	
Notes:	1) A test generator suitable to reduce for a defined period of time the amplitude of one or more half cycles (at zero crossings) of the AC mains voltage shall be used. The test generator shall be adjusted before connecting the EUT. The mains voltage reductions shall be repeated 10 times with an interval of at least 10 seconds. 2) These values are for 50 Hz /60 Hz, respectively			

Supplementary information to the IEC test procedures

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions of short time mains voltage interruptions and reductions while observing the weight indication of a single static load.

Test procedure in brief:

Preconditioning: None required.

Condition of the EUT: EUT is connected to the voltage supply and «on» for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to re-set if a significant fault has occurred.

Number of test cycles: At least one cycle.

Test information: The EUT shall be tested with one small static test load.
Stabilize all factors at nominal reference conditions. Apply one load or simulated load and record:

- (a) date and time;
- (b) temperature;
- (c) relative humidity;
- (d) voltage supply;
- (e) test load;
- (f) indications (as applicable);
- (g) errors;
- (h) functional performance

In accordance with the test specification in Table 14, interrupt the

voltages to the corresponding durations / number of cycles and conduct the test as detailed in IEC 61000-4-11 section 8.2.1. During interruption observe the effect on the EUT and record as appropriate.

Maximum allowable variations:

The difference between the indication due to the disturbance and the indication without the disturbance (intrinsic error) either shall not exceed 1 d, or the EUT shall detect and act upon a significant fault.

A.7.3.2 Electrical fast transients/burst immunity on the mains supply lines and on the I/O circuits and communication lines

Electrical fast transients/burst immunity tests are carried out at the positive and the negative polarity for at least 1 minute at each polarity in accordance with the basic standard IEC 61000-4-4 [19] and according to Tables 15.1 and 15.2.

Table 15.1: I/O circuits and communication lines

Environmental phenomena	Test specification	Test set-up
Fast transient common mode	0.5 kV (peak) 5/50 ns T_1/T_h 5 kHz rep. Frequency	IEC 61000-4-4
Note: Applicable only to ports or interfacing with cables whose total length may exceed 3m according to the manufacturer's functional specification.		

Table 15.2: AC and DC supply lines

Environmental phenomena	Test specification	Test set-up standard
Fast transient common mode	1 kV (peak) 5/50 ns T_1/T_h 5 kHz rep. frequency	IEC 61000-4-4
Note: DC supply lines, not applicable to battery-operated appliance that cannot be connected to the mains while in use.		

Supplementary information to the IEC test procedures

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions where fast transients are superimposed separately on the mains voltage, and on the I/O circuits and communication lines (if any), while observing the indications for one static test load.

Test procedure in brief:

Preconditioning: None required.

Condition of the EUT: The performance of the test generator shall be verified before connecting the EUT.

EUT is connected to the voltage supply and «on» for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to re-set if a significant fault has occurred.

Number of test cycles: At least one cycle.

Test information: Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than one minute for each amplitude and polarity. The injection network on the mains shall contain blocking filters to prevent the burst energy being dissipated in the mains. For the coupling of the bursts into the input/output and communication lines, a capacitive coupling clamp as defined in the reference standard shall be used.

Before any test stabilize the EUT under constant environmental conditions. Apply one small static test load and record:

- (a) date and time;
- (b) temperature;
- (c) relative humidity;
- (d) voltage supply;
- (e) test load;
- (f) indications (as applicable);
- (g) errors;
- (h) functional performance

Maximum allowable variations: The difference between the indication due to the disturbance and the indication without the disturbance (intrinsic error) either shall not exceed 1 d, or the EUT shall detect and act upon a significant fault.

A.7.3.3 Electrical surges on mains supply lines and on I/O circuits and communication (signal) lines

Electrical surge tests are carried out according to IEC 61000-4-5 [20] and according to Table 16.

Table 16

Environmental phenomena	Test specification	Test set-up
Surges on mains supply lines and on I/O circuits and communication lines	0.5 kV (peak) line to line 1.0 kV line to earth a) 3 positive and 3 negative surges applied synchronously with AC supply voltage in angles 0°, 90°, 180° and 270°.	IEC 61000-4-5

	b) 3 positive and 3 negative surges applied on DC supply lines and on I/O circuits and communication lines.	
Note:	This test is only applicable in those cases where the risk of a significant influence of surges can be expected such as outdoors installations and/or indoor installations connected to long communication and signal lines (lines longer than 30 m or those lines partially or fully installed outside the buildings regardless of their length). It is also applicable to DC powered instruments if the voltage supply comes from a DC network.	

Supplementary information to the IEC test procedures

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions where electrical surges are applied separately to the mains supply lines, and to the I/O circuits and communication lines (if any), while observing the indications for one static test load.

Test procedure in brief:

Preconditioning: None required.

Condition of the EUT: The characteristics of the test generator shall be verified before connecting the EUT.

EUT is connected to the voltage supply and «on» for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to re-set if a significant fault has occurred.

Number of test cycles: At least one cycle.

Test information: The test consists of exposure to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and minimum time interval between two successive pulses are defined in IEC 61000-4-5.

The injection network depends on the lines the surge is coupled to and is defined in IEC 61000-4-5.

The EUT shall be tested with one small static test load.

Before any test stabilize the EUT under constant environmental conditions. Apply one load or simulated load and record:

- (a) date and time;
- (b) temperature;
- (c) relative humidity;

- (d) voltage supply;
- (e) test load;
- (f) indications (as applicable);
- (g) errors;
- (h) functional performance

Maximum allowable variations:

The difference between the indication due to the disturbance and the indication without the disturbance ([intrinsic error](#)) either shall not exceed 1 d, or the EUT shall detect and act upon a significant fault.

A.7.3.4 Electrostatic discharges

Electrostatic discharge tests are carried out according to basic standard IEC 61000-4-2 [\[21\]](#) and according to Table 17.

Table 17 - Electrostatic discharge test

Environmental phenomena	Test specification		Test set-up
Electrostatic discharge	Test voltage	Levels ⁽¹⁾	IEC 61000-4-2
	contact discharge	6 kV	
	air discharge	8 kV	
Notes:	<div>1) Tests shall be performed at the specified lower levels, <u>starting with 2 kV and proceeding with 2 kV steps</u> up to and including the level specified above <u>in accordance with IEC 61000-4-2</u>.</div> <div>2) The 6 kV contact discharge shall be applied to conductive accessible parts. Metallic contacts, e.g. in battery compartments or in socket outlets are excluded from this requirement.</div>		

Supplementary information to the IEC test procedures

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions where electrostatic discharges are applied while observing the weight indication for one small static test load.

Test procedure in brief:

Preconditioning: None required.

Condition of the EUT: The performance of the test generator shall be verified before connecting the EUT.

EUT is connected to the voltage supply and «on» for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to re-set if a significant fault has occurred.

Number of test cycles: At least one cycle.

Test information: Contact discharge is the preferred test method. 20 discharges (10 with positive and 10 with negative polarity) shall be applied on each accessible metal part of the enclosure. The time interval between successive discharges shall be at least 10 seconds. In the case of a non conductive enclosure, discharges shall be applied on the horizontal or vertical coupling planes as specified in the reference standard. Air discharges shall be used where contact discharges cannot be applied.

Before any test stabilize the EUT under constant environmental conditions. Apply one small static test load and record:

- (a) date and time;
- (b) temperature;
- (c) relative humidity;
- (d) voltage supply;
- (e) test load;
- (f) indications (as applicable);
- (g) errors;
- (h) functional performance

Maximum allowable variations: The difference between the indication due to the disturbance and the indication without the disturbance (intrinsic error) either shall not exceed 1 d, or the EUT shall detect and act upon a significant fault.

A.7.3.5 Immunity to electromagnetic fields

A.7.3.5.1 Immunity to radiated electromagnetic fields

Radiated, radio-frequency, electromagnetic (EM) field immunity tests (radio-frequency EM fields higher than 80 MHz) are carried out in accordance to IEC 61000-4-3 [22] and according to Table 18.

Table 18 - Radiated electromagnetic susceptibility

Test specification

Environmental phenomena	Frequency ranges MHz	Field strength (V/m)	Test set-up
Radiated electromagnetic field	80 to 2000 ⁽¹⁾	10	IEC 61000-4-3
	26 to 80 ⁽²⁾		
Modulation	80 % AM, 1 kHz sine wave		
Notes:	1) IEC 61000-4-3 only specifies test levels above 80 MHz. For frequencies in the lower range the test methods for conducted radio frequency disturbances according to A.7.3.4.2 is recommended. 2) For EUTs having no mains or other I/O ports available so that the test according to A.7.3.4.2 cannot be applied, the lower limit of the radiation test is 26 MHz.		

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Supplementary information to the IEC test procedures

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions of specified radiated electromagnetic fields applied while observing the weight indication for one small static test load.

Test procedure in brief:

Preconditioning: None required.

Condition of the EUT: The performance of the test generator shall be verified before connecting the EUT.

EUT is connected to the voltage supply and «on» for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test except to re-set if a significant fault has occurred.

Number of test cycles: At least one cycle.

Test information: The EUT shall be exposed to EM field strength as specified in Table 18. The frequency ranges to be considered are swept with the modulated carrier. The performance of the EUT shall be verified.

Before any test stabilize the EUT under constant environmental conditions. Apply one small static test load and record:

- (a) date and time;
- (b) temperature;
- (c) relative humidity;

- (d) voltage supply;
- (e) test load;
- (f) indications (as applicable);
- (g) errors;
- (h) functional performance

Maximum allowable variations:

The difference between the indication due to the disturbance and the indication without the disturbance (**intrinsic error**) either shall not exceed 1 d, or the EUT shall detect and act upon a significant fault.

A.7.3.5.2 Conducted electromagnetic immunity tests

Conducted, radio-frequency, electromagnetic field (EM) immunity tests (radio-frequency EM fields lower than 80 MHz) are carried out in accordance to IEC 61000-4-6 [23] and according to Table 19.

Table 19 - Conducted electromagnetic susceptibility

Test specification			
Environmental phenomena	Frequency range MHz	RF amplitude (50 ohms) V (e.m.f)	Test set-up
Conducted electromagnetic field	0.15 to 80	10 V	IEC 61000-4-6
Modulation	80 % AM, 1 kHz sine wave		
Note:	This test is not applicable when the EUT has no mains or other input port.		

Supplementary information to the IEC test procedures

Object of the test: To verify compliance with the provisions in 4.1.2 under conditions of specified conducted electromagnetic fields applied while observing the weight indication for one small static test load.

Test procedure in brief:

Preconditioning: None required.

Condition of the EUT: The performance of the test generator shall be verified before connecting the EUT.

EUT is connected to the voltage supply and «on» for a time period equal to or greater than the warm-up time specified by the manufacturer. Adjust the EUT as close to zero indication as practicable, prior to the test. Zero-setting functions shall not be in operation and are not to be adjusted at any time during the test

except to re-set if a significant fault has occurred.

Number of test cycles: At least one cycle.

Test information: Before any test stabilize the EUT under constant environmental conditions. Apply one small static test load and record:

- (a) date and time;
- (b) temperature;
- (c) relative humidity;
- (d) voltage supply;
- (e) test load;
- (f) indications (as applicable);
- (g) errors;
- (h) functional performance

Maximum allowable variations: The difference between the indication due to the disturbance and the indication without the disturbance (intrinsic error) either shall not exceed 1 d (T.4.2.7), or the EUT shall detect and act upon a significant fault.

A.8 SPAN STABILITY TEST (4.4.3)

When the instrument is subjected to the span stability test in Table 19:

- the maximum allowable variation in the errors of indication shall not exceed half the absolute value of the maximum permissible error in 2.2.2 Table 2 for the test load applied on any of the n measurements;
- where the differences of the results indicate a trend more than half the allowable variation specified above, the test shall be continued until the trend comes to rest or reverses itself, or until the error exceeds the maximum allowable variation.

No reference to international standards can be given at the present time.

Table 19 - Span stability test

<u>Test</u>	<u>Characteristic under test</u>	<u>Condition applied</u>
<u>Span stability</u>	<u>Stability</u>	<u>1/2 absolute MPE</u>
<u>Notes:</u> 1) <u>The maximum permissible error for the zero point shall also be taken into consideration.</u>		

2) MPE: maximum permissible error on initial verification in 2.2.2 Table 2.

Test method:	Span stability.
Object of the test:	To verify compliance with the provisions in 4.4.3 after the EUT has been subjected to the performance tests.
Test procedures in brief:	<p>The test consists of observing the variations of the error of the EUT or simulator under sufficiently constant ambient conditions (reasonable constant conditions in a normal laboratory environment) at various intervals: before, during, and after the EUT has been subjected to performance tests.</p> <p>The performance tests shall include the temperature test and, if applicable, the damp heat test; an endurance test shall not be included. Other performance tests listed in this Annex may be performed.</p> <p>The EUT shall be disconnected twice from the mains power supply (or battery supply where fitted) for at least 8 hours during the period of the test. The number of disconnections may be increased if so specified by the manufacturer or at the discretion of the approval authority in the absence of any specification.</p> <p>In the conduct of this test, the operating instructions for the instrument as supplied by the manufacturer shall be considered.</p> <p>The EUT shall be stabilized at sufficiently constant ambient conditions after switch-on for at least five hours, and at least 16 hours after the temperature and damp heat tests have been performed.</p>
Test severities:	<p>Test duration: 28 days or the time period necessary to conduct the performance tests, whichever is less.</p> <p>Time (t) between tests (days): $0.5 < t < 10$.</p>
Test load:	<u>Near</u> maximum capacity (Max); the same test weights shall be used throughout the test.
Maximum allowable variations:	The variation in the errors of indication shall not exceed half the absolute value of the maximum permissible error in 2.2.2 Table 3 for the test load applied on any of the n measurements.
Number of tests (n):	At least <u>eight</u> , except where the difference of the results

indicates a trend more than half the allowable variation specified, the measurements shall be continued until the trend comes to rest or reverses itself, or until the error exceeds the maximum allowable variation.

Precondition:	None required.
Test equipment:	Verified mass standards or simulated load.
Condition of the EUT:	Normal power supplied and "on" for a time period equal to or greater than the warm-up time specified by the manufacturer.
Test sequence:	<p>Stabilize all factors at nominal reference conditions.</p> <p>Adjust the EUT as close to zero as possible. Automatic zero-tracking shall be made inoperative and automatic built-in span adjustment device shall be made operative.</p> <ul style="list-style-type: none">• Initial measurement <p>Determine the span error using the following method:</p> <p>(1) Determine the initial zero error (E_0)</p> <p>If necessary disable any automatic zero-setting or zero-tracking devices by placing a "zero weight" of for example 10 times the scale interval on the load receptor. Note the indication at zero (I_0).</p> <p>Either by use of an indicator with a suitable higher resolution scale interval or using the change point weight method in A.3.5.2.1 (noting the total addition change point weight ΔL_0) determine and record the initial zero error (E_0).</p> <p>(2) Determine the error at near Max capacity (E_L)</p> <p>Carefully remove the change point weights (if used) and apply the test load (or simulated load) and note the indication (I_L). Either by use of an indicator with a suitable higher resolution scale interval or using the change point weight method in A.3.5.2.1 (noting the total addition change point weight ΔL) determine and record the error at near Max capacity (E_L).</p> <p>Record:</p> <ul style="list-style-type: none">a) date and time;b) temperature;c) barometric pressure;

- d) relative humidity;
- e) value of 0.1 d;
- f) test load;
- g) total of added change point weights at zero load ΔL_0 ;
- h) total of added change point weights at test load ΔL ;
- i) the following indications:
 - indication at zero (I_0);
 - indication of test load (I_L);
- j) calculate:
 - initial zero error E_0 ;
 - error at test load (E_L);
- k) change in location and apply all necessary corrections resulting from variations of temperature, pressure, etc. between the various measurements.

Immediately repeat steps (1) and (2) four more times and determine and record the average value of the error for the five tests.

- Subsequent measurements

After observing the time between measurements requirement repeat the test sequence (1) to (2) once recording the data above unless:

- either the result is outside the maximum allowable variation, or
- the range of the five readings of the initial measurement is more than 0.1 d, in which case continue four more times repeating steps (1) and (2) recording the data above and determine and record the average value of the error of the five tests.

The measurements shall continue until there are at least eight measurements except where the difference of the results indicates a trend more than half the allowable variation specified, the measurements shall be continued until the trend comes to rest or reverses itself, or until the error exceeds the maximum allowable variation.

A.9 PROCEDURE FOR IN-SITU TESTS

A.9.1 General

Note the accuracy class required for wagon weighing and train weighing.

Ensure that the desired scale interval and the maximum wagon mass comply with 2.2.2. Check that the minimum capacity complies with 2.5.

For type approval, tests shall be carried out in accordance with the requirements of this Recommendation.

For initial verification, tests shall be carried out corresponding to the normal site operation of the instrument.

A.9.2 Control instrument

Establish whether or not the instrument is to be used as an integral control instrument. If it is an integral control instrument then it shall comply with 6.1.2 and be tested in accordance with 6.2 and A.5.2.

If wagons have to be moved over some distance from a separate control instrument to the EUT, the conditions must be closely controlled. Differences in weather conditions may cause errors which will not be determinable and so this should be avoided where possible.

If there is no suitable control instrument for full-draught weighing available with an acceptable accuracy or scale of suitable length, or in an acceptable distance, a control instrument for bogie partial weighing (separate or integral) may be used to determine the static reference wagon mass, in accordance with the requirements in A.9.3.1.2.

A.9.3 Weighing

A.9.3.1 Static weighing test

When the instrument is provided with a static weighing mode, the static weighing test detailed at A.5.2.2.2 shall be applied. When the instrument has been tested according to the test at A.9.2 then those results may be used.

A.9.3.1.1 Full-draught weighing of reference wagons

The conventional true value of the reference wagon mass (uncoupled, coupled or train) shall normally be determined by full-draught weighing of the reference wagons with the appropriate load conditions on a suitable control instrument (see 6.5). A minimum of four different wagon weighing for each reference wagon shall be conducted using the following method:

- a) Weigh each static reference wagon in-turn (alternating from each direction after zero-setting before each wagon weighing) on the control instrument (6.1) and record the indications;
- b) Calculate the mean value of the four wagon masses for determining the conventional true value of the reference wagon mass.

A.9.3.1.2 Partial weighing of reference wagons using separate or integral control instrument

The static reference single axle or bogie load shall be determined for the reference wagon appropriately such that the axle or bogie weighing cover, as far as practicable, the weighing range of the instrument. With the wagon stationary and the wheels on the axle or bogie being weighed fully supported by the load receptor, a minimum of four different axle or bogie weighing for each appropriately loaded single-axle or bogie shall be conducted using the following method.

Weigh each axle or bogie of the static reference wagon in-turn (alternating from each direction after zero-setting before each wagon weighing) on the control instrument (6.1) and record the indications. After the axles or bogies have been weighed, calculate the value of the mass of the wagon by the summation of the recorded values for the all axles or bogies and calculate the mean value of the four wagon masses for determining the static reference wagon mass.

A.9.3.1.3 Rail-alignment correction

For partial weighing of two-axle wagons, apply the alignment correction procedure in Annex B to the totalised value.

For partial bogie weighing, additional installation conditions are provided in Annex C.

A.9.3.2 In-motion weighing tests with the reference wagons

A.9.3.2.1 General requirements

Prior to any test adjust the instrument under test in-situ and in accordance with the manufacturer's specifications.

All weighing operations shall be started with the reference wagon positioned in advance of the approach apron at a distance sufficient for the wagon to reach and maintain constant test speed before arriving at the apron and during each in-motion test.

Test runs shall be conducted using the reference wagons with the appropriate loading conditions for each wagon in accordance with 6.3.

For each reference wagon the number of test runs shall be as specified in 6.4.

All test runs shall be conducted at operating speeds that are within the range of speeds for which the instrument is be evaluated, with at least one test run close to the:

- (i) maximum operating speed (v_{max}),
- (ii) minimum operating speed (v_{min})
- (iii) typical site operating speed.

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For each of the above weighing operations, ensure that the wagon is stationary, with the wagon being weighed fully supported by the load receptor. ¶
<#> Calculate the mean static reference mass for each wagon according to the following: ¶

$$\overline{\text{Wagon}_i} = \frac{\sum_1^5 \text{Wagon}_i}{5} \quad \text{wh}$$

ere ¶

¶
i is the single wagon rank ¶
5 is the number of weighments of each static wagon, ¶
Wagon_i is the recorded mass for that wagon ¶

¶
<#> For the purposes of this Recommendation, the conventional true value of reference wagon mass shall be the mean value of the wagon mass as calculated in (1) above. Alternatively, for partial weighing of static two-axle wagons, calculate the mean static reference mass for the two-axle wagon according to the following: Weigh each axle of the two-axle wagon on the load receptor and record the indicated single axle-weights. Ensure that the wagon is stationary and conduct the weighing operation five times for each single-axle loaded appropriately as specified in A.9.3.1.3. ¶

¶
2) Calculate the mean static reference axle-mass for each

$$\overline{\text{Axle}_i} = \frac{\sum_1^3 \text{Axle}_i}{5} \quad \text{¶}$$

¶
where ¶

¶ ... [1]

Deleted: carried out over the centre of the load receptor

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A.9.3.2.2 Wagon weighing (5.1.3.3.1)

- (1) For each individual reference wagon (uncoupled or coupled), record the mass of the wagon as indicated by the instrument under test. Calculate the difference (error) in each recorded mass of the wagon and its respective static reference wagon mass determined in A.9.3.1.1.
- (2) The maximum difference (error) between any recorded wagon mass and the conventional true value of the static reference wagon mass shall comply with the requirements in 2.2.1.1.

A.9.3.3 Train weighing (5.1.3.3.2)

The mass of the reference wagons in the train shall be summed and any errors shall comply with the requirements in 2.2.1.2 and applied to the summation.

A.9.4 Test of operating speed interlock (A.6.3)

To test the functioning of the operating speed interlock, test runs with one of the reference wagons shall be made at speeds outside the range of operating speeds:

- a) at a speed of at least 5 % in excess of the maximum operating speed (v_{max})
- b) at a speed of at least 5 % below the minimum operating speed (v_{min}) (if applicable).

The instrument shall detect the above conditions and not indicate or print any measurement result unless there is a clear warning message on the indication and the printout (3.4.5.3).

ANNEX B

Deleted: A.9.3.3.3 Coupled-wagon weighing (5.1.3.2.2)(1) For each coupled reference wagon, record the mass of the individual wagons as indicated or printed by the instrument under test. Calculate the mean mass of each individual wagon of the test runs conducted at the typical site operating speed:¶

$$\overline{\text{Wagon}}_i = \frac{\sum_{i=1}^n \text{Wagon}_i}{n} \quad i \text{ is}$$

the wagon rank¶

n is the number of test runs¶

Wagon_i is the recorded mass for that individual wagon(2) Summate the mean mass values of the individual wagons to determine the mean total mass of the coupled reference wagon:¶

¶
Coupled wagon:

$$= \sum_{i=1}^w \overline{\text{Wagon}}_i \quad ¶$$

w is the number of individual wagons in that reference coupled-wagon.(3)

Calculate the corrected mean mass for the individual wagons as follows:

$$\overline{\text{CorrWagon}}_i = \overline{\text{Wagon}}_i \times \frac{C}{C}$$

¶
Coupled wagon_{ref} is the conventional true value of the mass of the coupled reference wagon determined by full-draught weighing as specified in 6.7. For the purpose of providing traceability, the sum of the corrected mean mass for the individual wagons in the coupled reference wagon should equal the conventional true value of the total mass of the coupled reference wagon

$$\overline{\text{Coupled wagon}}_{ref} = \sum_{i=1}^w \overline{\text{Cc}}$$

¶
where ¶

¶
w is the number of individual wagons in the coupled reference wagon¶

¶
Calculate the deviation of each coupled reference wagon mass from its respective static coupled reference wagon mass. Any errors shall comply with the requirements in 2.2.1.1. [2]

Deleted: Tests are the same as in A.9.3.3.3 and may be carried out in conjunction with A.9.3.3.3 without repeating the test, if both modes of operation are required.¶

INSTRUCTIONS FOR THE ALIGNMENT CORRECTION OF SINGLE-AXLE WEIGHING INSTRUMENTS

B.1 General

The alignment correction shall only be applied to instruments that operate by partial weighing of two-axle wagons under the conditions in 6.1 and is not recommended as a substitute for verification of reference wagons by full draught weighing.

B.2 Exemption

Instruments that operate by partial weighing are exempt from the alignment check provided the following:

- the top surface of both rails along the length of the weigh zone are vertically aligned to ± 2 mm, and
- the alignment has been checked along both rails at not less than two positions on the load receptor and not less than two positions within a wagon length from the load receptor on each associated apron.

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B.3 Alignment check

The alignment correction is conducted with the use of a two-axle uncoupled static wagon similar to those wagons used for in-motion testing. Each single-axle shall be tested at two different axle loads, e.g. one near Min (empty wagon) and one near Max (wagon loaded with additional weights specified in (4)). The weighing operations are conducted as follows:

- 1) Weigh each axle of the two-axle wagon in the centre and at each end of the load receptor and record the indicated single axle-loads. Ensure that the wagon is empty and stationary and conduct the weighing operation once for each axle.
- 2) Calculate the mean static reference axle-load for each axle:

$$\overline{Axle_i} = \frac{\sum_{i=1}^3 Axle_i}{3}$$

where

i is the single-axle rank
 3 is the number of weighments of each static axle,
 $Axle_i$ is the recorded load for that axle

- 3) Summate the two mean single-axle loads to determine the mean of the total mass of the empty static wagon:

$$\overline{EmptyWagon} = \sum_{i=1}^2 \overline{Axle_i}$$

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Field Code Changed

4) Repeat weighing operations in (1) to (3) using the specified standard weights evenly distributed on the empty wagon. The sum of the standard weights used shall be at least equal to the larger of the following values:

- a) the difference between the maximum capacity and 1.5 times the weight of the wagon as determined in (3), with the result rounded down to the nearest 1 tonne;
- b) ten tonnes.

5) The difference between the value obtained in (3) for the empty static wagon and the value in (4) for the loaded static wagon shall be subtracted from the total value of the standard weights, the result being the alignment correction.

6) The absolute value of the alignment correction shall be added to the totalized recorded weight of each reference wagon weighed while stationary and uncoupled on a single-axle weighing instrument.

7) Example of alignment correction test sheet:

Accuracy class: 1

Maximum capacity: $a = 35$ t

Typical wagon tare: $b = 11.5$ t

Mass of standard weight required: $c = 17$ t ($a - 1.5 b$, to nearest tonne)

Scale interval: 0.1 t

Scale interval for stationary load: 0.01 t

Summary of test report

	Position on load receptor	Recorded mass (t)	
		Empty wagon	Loaded wagon
First axle	Leading end	5.76	14.27
	Middle	5.75	14.26
	Trailing end	5.75	14.26
Second axle	Leading end	5.75	14.25
	Middle	5.75	14.25
	Trailing end	5.74	14.24
Total of six weighings		34.50	85.53
Divide total by three		$d = 11.50$	$e = 28.51$
Derived mass of standard weight		$f = e - d = 17.01$	
Alignment correction		$c - f = -0.01$	

The absolute alignment correction value is used to obtain the corrected the totalized recorded mass, for example, if the totalized recorded mass is 41.38 t, the corrected mass will be:

$$41.38 + (-0.01) = 41.37 \text{ t}$$

Note: The calibration correction computed in this example is not intended to be typical.

ANNEX C

INSTRUCTIONS FOR THE INSTALLATION AND OPERATION OF AUTOMATIC RAIL-WEIGHBRIDGES

C.1 Installation of weigh-in-motion instruments

These requirements are subject to change in recognition of future technical developments.

C.2 Weigh zone

The weigh zone shall comprise a single load receptor with an apron on both ends.

C.3 Approach rails

The approach rails shall be in the same plane and alignment as the weigh rails and shall be properly anchored. Approach and scale rails shall be the same weight. Rail shall be continuous with no joints on the scale or approaches

C.4 Reference wagons

The reference wagons are completely uncoupled when the mass of each bogie is determined

C.1.4 Spilt material and ice

Care shall be taken in the design and operation of the installation to ensure that, as far as possible, a build-up of spilt material and ice on the weigh zone of the instrument either does not occur, or is removed regularly.

C.1.5 Overhead structures

Load receptors should not be installed beneath a loading or conveying mechanism from which loose material might fall.

Deleted: shall

C.1.7 Notice of speed restrictions

There shall be means to ensure that all drivers of railway vehicles that cross the load receptor are aware of the minimum and maximum operating speeds at which they can proceed.

BIBLIOGRAPHY

Below are references to Publications of the IEC, ISO and OIML, where mention is made in some of the tests in Annex A. Use these or refer to the most recent issue of the publication valid at the time of testing the instrument.

<u>Ref.</u>	<u>Standards and reference documents</u>	<u>Description</u>
[1]	<u>International Vocabulary of Basic and General Terms in Metrology (VIM) (1993)</u>	<u>Vocabulary, prepared by a joint working group consisting of experts appointed by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML</u>
[2]	<u>International Vocabulary of Terms in Legal Metrology, BLM, Paris (2000)</u>	<u>Vocabulary including only the concepts used in the field of legal metrology. These concepts concern the activities of the legal metrology service, the relevant documents as well as other problems linked with this activity. Also included in this Vocabulary are certain concepts of a general character which have been drawn from the VIM.</u>
[3]	<u>OIML B 3 (2003) OIML Certificate System for Measuring Instruments (formerly OIML P1)</u>	<u>Provides rules for issuing, registering and using OIML Certificates of conformity</u>
[4]	<u>OIML D11 (2004) General requirements for electronic measuring instruments</u>	<u>Contains general requirements for electronic measuring instruments</u>
[5]	<u>OIML R111 (2004) Weights of classes E1, E2, F1, F2, M1, M1-2, M2, M2-3 and M3</u>	<u>Provides the principal physical characteristics and metrological requirements for weights used with and for the verification of weighing instruments and weights of a lower class.</u>
[6]	<u>OIML R 60 (2000) Metrological regulation for load cells</u>	<u>Provides the principal static characteristics and static evaluation procedures for load cells used in the evaluation of mass</u>
[7]	<u>OIML R 76 -1 – Non-automatic weighing instruments. Second Committee draft revision (2005)</u>	<u>Provides the principal physical characteristics and metrological requirements for the verification of non-automatic weighing instruments</u>
[8]	<u>OIML D 19 (1988) Pattern evaluation and pattern approval</u>	<u>Provides advice, procedures and influencing factors on pattern evaluation and pattern approval</u>
[9]	<u>OIML D 20 (1988) Initial and subsequent verification of measuring instruments and processes</u>	<u>Provides advice, procedures and influencing factors on the choice between alternative approaches to verification and the procedures to be followed in the course of verification</u>
[10]	<u>IEC 60068-2-1 (1990-05) with amendments 1 (1993-02) and 2 (1994-06)</u>	<u>Basic environmental testing procedures - Part 2: Tests, Test Ad: Cold, for heat dissipating equipment under test (EUT), with gradual change of temperature.</u>
<u>Ref.</u>	<u>Standards and reference documents</u>	<u>Description</u>

[11]	<u>IEC 60068-2-2 (1974-01) with amendments 1 (1993-02) and 2 (1994-05)</u>	<u>Basic environmental testing procedures, Part 2: Tests, Test Bd: Dry heat, for heat dissipating equipment under test (EUT) with gradual change of temperature.</u>
[12]	<u>IEC 60068-3-1 (1974)</u>	<u>Part 3: Background information, section 1: Cold and dry heat tests.</u>
[13]	<u>IEC 60068-2-78 (2001-08)</u>	<u>Environmental testing, Part 2: Tests, Test Cb: Damp heat, steady state. Primarily for equipment.</u>
[14]	<u>IEC 60068-3-4 (2001-08)</u>	<u>Environmental testing – Part 3-4: Guidance for damp heat tests.</u>
[15]	<u>IEC 61000-2-1 (1990-05)</u>	<u>Electromagnetic compatibility (EMC) Part 2: Environment Section 1: Description of the environment- Electromagnetic environment for low-frequency conducted disturbances and signalling in public power supply systems</u>
[16]	<u>IEC 61000-4-1 (2004):</u>	<u>Basic EMC Publication Electromagnetic compatibility (EMC) Part 4: Testing and measurement techniques Section 1: Overview of IEC 61000-4 series</u>
[17]	<u>IEC 60654-2 (1979-01), with amendment 1 (1992-09)</u>	<u>Operating conditions for industrial-process measurement and control equipment - Part 2: Power.</u>
[18]	<u>IEC 61000-4-11 (2004-03)</u>	<u>Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques - Section 11: Voltage dips, short interruptions and voltage variations immunity tests.</u>
[19]	<u>IEC 61000-4-4 (2004-07)</u>	<u>Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test. Basic EMC publication.</u>
[20]	<u>IEC 61000-4-5 (2001-04) consolidated Edition 1.1 (including amendment 1 and Correction 1)</u>	<u>Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques Section 5: Surge immunity test.</u>
[21]	<u>IEC 61000-4-2 (1995-01) with amendment 1 (1998-01) and amendment 2 (2000-11) -04) Ed. 1.2.</u>	<u>Basic EMC Publication. Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 2: Electrostatic discharge immunity test. Basic EMC Publication.</u>
[22]	<u>IEC 61000-4-3 Consolidated Edition 2.1 (including amendment 1) (2002-09)</u>	<u>Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test.</u>
Ref.	<u>Standards and reference documents</u>	<u>Description</u>

[23]	<u>IEC 61000-4-6 Consolidated Edition 2.1 (including amendment 1) (2004-11)</u>	<u>Electromagnetic Compatibility (EMC) - Part 4: Testing and measurement techniques - Section 6: Immunity to conducted disturbances, induced by radio-frequency fields.</u>
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A.9.3.2.3 Determining the conventional true value of the reference wagon mass

Select the required number of reference wagons as specified in 6.4. Weigh each reference wagon in-turn on the control instrument and record the indicated wagon mass. This operation shall be conducted five times with the minimum number of reference wagons and appropriate loading conditions for each wagon in accordance with 6.4.

For each of the above weighing operations, ensure that the wagon is stationary, with the wagon being weighed fully supported by the load receptor.

Calculate the mean static reference mass for each wagon according to the following:

$$\overline{\text{Wagon}_i} = \frac{\sum_{i=1}^5 \text{Wagon}_i}{5} \quad \text{where}$$

i is the single wagon rank

5 is the number of weighments of each static wagon,

Wagon_i is the recorded mass for that wagon

For the purposes of this Recommendation, the conventional true value of reference wagon mass shall be the mean value of the wagon mass as calculated in (1) above. Alternatively, for partial weighing of static two-axle wagons, calculate the mean static reference mass for the two-axle wagon according to the following: Weigh each axle of the two-axle wagon on the load receptor and record the indicated single axle-weights. Ensure that the wagon is stationary and conduct the weighing operation five times for each single-axle loaded appropriately as specified in A.9.3.1.3.

2) Calculate the mean static reference axle-mass for each

$$\text{axle: } \overline{\text{Axle}_i} = \frac{\sum_{i=1}^5 \text{Axle}_i}{5}$$

where

i is the single-axle rank

5 is the number of weighments of each static axle,

Axle_i is the recorded mass for that axle

3) Summate the two mean single-axle mass to determine the mean of the reference wagon mass:

$$\overline{\text{Wagon}} = \sum_{i=1}^2 \overline{\text{Axle}_i}$$

4) Apply the alignment correction procedure given in Annex B to the totalised value to determine the conventional true value of the reference wagon mass.

A.9.3.3.3 Coupled-wagon weighing (5.1.3.2.2)(1) For each coupled reference wagon, record the mass of the individual wagons as indicated or printed by the instrument under test. Calculate the mean mass of each individual wagon of the test runs conducted at the typical site operating speed:

$$\overline{\text{Wagon}_i} = \frac{\sum_{i=1}^n \text{Wagon}_i}{n} \quad i \text{ is the wagon rank}$$

n is the number of test runs

Wagon_i is the recorded mass for that individual wagon(2) Summate the mean mass values of the individual wagons to determine the mean total mass of the coupled reference wagon:

$$\overline{\text{Coupledwagon}_i} = \sum_{i=1}^w \overline{\text{Wagon}_i}$$

w is the number of individual wagons in that reference coupled-wagon.(3) Calculate the corrected mean mass for the individual wagons as follows:

$$\overline{\text{CorrWagon}_i} = \overline{\text{Wagon}_i} \times \frac{\overline{\text{Coupledwagon}_{\text{ref}}}}{\overline{\text{Coupledwagon}_i}}$$

$\overline{\text{Coupledwagon}_{\text{ref}}}$ is the conventional true value of the mass of the coupled reference wagon determined by full-draught weighing as specified in 6.7. For the purpose of providing traceability, the sum of the corrected mean mass for the individual wagons in the coupled reference wagon should equal the conventional true value of the total mass of the coupled reference wagon $\overline{\text{Coupledwagon}_{\text{ref}}} = \sum_{i=1}^w \overline{\text{Corrwagon}_i}$

where

w is the number of individual wagons in the coupled reference wagon

Calculate the deviation of each coupled reference wagon mass from its respective static coupled reference wagon mass. Any errors shall comply with the requirements in 2.2.1.1.

(5) Calculate the deviation of each individual wagon mass from its respective:

static reference wagon mass, and
corrected mean wagon mass.

Any errors shall comply with the requirements in 2.2.1.1 for the applicable accuracy class.